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BOTANY AND HUMAN AFFAIRS[1]

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UNITED STATES DEPARTMENT OF AGRICULTURE

"Botany and Human Affairs" is a rather broad ubject to present in twenty-five minutes. But I am dvised by Director Gager that various special phases ill be discussed in detail by other speakers, so that I ay confine my remarks to a more general treatment f the larger aspects of the subject, creating, if you lease, a background for the real pictures to come later n this program.

All animals, including man, are dependent for food irectly or indirectly on some form of green or chlorohyll-bearing plant life. The study of these organms, that make man's life possible, is of as great funamental importance as the study of man himself.

Botany in its broad sense is the systematized knowledge we possess of the vegetable kingdom as a whole. It includes all that is known about plants, their history through the ages, as we get it in geology and paleontology, the description and classification of all known forms of living plants; the study of their origin, life relationships and development (embryology, genetics); their structure; (histology and cytology and morphology) their physiology, their composition, modification, mutation and evolution; their cultivation, propagation and breeding; their diseases, their relation to each other and to other organisms and to the factors of their environment. From the economic aspect it is evident that this includes much of agriculture, forestry, horticulture, pharmacognosy, floriculture and cognate subjects.

At the lower end of this great kingdom of plant life we find the beginning of what we know as living

[1] Address delivered at the opening program of the wenty-fifth anniversary exercises of the Brooklyn Botanic arden, May 13, 1935.

organisms, those complex molecules that we call protoplasm, that are able under favorable conditions to sustain and reproduce themselves from the inorganic elements of their environment, the so-called autotrophic microorganisms. These are the simplest types of living organisms. Some of them are so small that they are invisible under the highest powers of the microscope. Others are more like fungi or algae without chlorophyll, though some of them do contain chromogen materials. The energy that they need for their life processes they are able to draw from the inorganic materials of their environment, from combinations of nitrogen, phosphorus, sulfur, chlorine, potassium, calcium, magnesium, iron, copper, manganese and possibly a few other elements. This ability to extract energy from inorganic compounds, utilizing it for the reduction of carbon dioxide to organic compounds, is limited to a very few species, but they are of very great importance in soil formation and in soil fertility. They include such genera as *Nitrosomonas, Nitrosococcus,* which oxidize ammonia to nitrite, *Nitrobacter,* which oxidizes nitrite to nitrate, and species of the genus *Thiobacillus,* which oxidize sulfur and its compounds, utilizing also light energy. Others oxidize iron and manganous compounds and others oxidize hydrogen. Some of these contain pigment and may be algae rather than true bacteria.

Then comes the great group of microscopic parasitic and saprophytic *heterotrophic Bacteria*. We know now as a result of the facts brought to light by those who study these forms of plant life that they bring about fundamental transformations and changes necessary to the existence of higher forms of life. In association with other plants or plant remains some of them oxidize atmospheric nitrogen into nitric acid and ammonia in forms available to higher plants. Some of them have formed cooperative or symbiotic relations with higher plants, as for example with Leguminosae, the alfalfas, clovers, peas, beans, which are among our most valuable soil-building and feed and food crops. They prepare the food material for higher plants. They separate these materials again when the plant or the animal that feeds on them dies. Others have become parasitic, causing disease and destruction to higher plants or animals. Crown gall or plant cancer, pear blight and various rots and wilts, some extremely destructive, are examples of plant diseases caused by bacteria. Tuberculosis, anthrax, tetanus, typhoid fever, cholera, pneumonia are among the well-known and destructive animal diseases caused by bacteria.

In this same general group of parasitic and saprophytic organisms are the fungi, yeasts, moulds, rusts, smuts, toadstools, mushrooms, bracket fungi, and hosts of others, some helpful and valuable, others harmful and causing destructive diseases of plants and animals. This group is especially prolific in species causing plant diseases. Some of the most destructive and best-known examples are the black rot of grapes, bitter rot of apples, apple scab, peach and plum rot, the fusarium wilts of cotton, flax and cow peas; the root rot of corn and the scab of wheat and barley; the rusts and smuts of wheat and other cereals and a great variety of other plants; the mildew rots of grape, potato and hops; the heart rots of trees and various root rots; chestnut blight and Dutch elm disease.

Most of these fungi have complicated life histories living in different forms on totally unrelated plants. One form, or stage, of the black rust of cereals, for example, lives only on certain species of barberry (*B. vulgaris* group), from which it moves again to the cereal host. The blister rust of the white pine passes part of its life on gooseberry and currant leaves. The unraveling of these life histories is the most effective means to a knowledge of effective control.

The black rust of wheat of the bread varieties can be controlled in part by destroying the common barberry (*B. vulgaris*) in the regions where these wheats are grown. The blister rust of white pine can not be prevented, except by destroying the gooseberries and currants in the vicinity of white pines. These are simply two well-known examples of hundreds of other similar associations, some with plants and some with insects, highly important to our welfare to understand. Dr. Geo. M. Reed, of the Brooklyn Botanic Garden, is doing some outstanding work on smut diseases of cereal grains. These diseases are very destructive and difficult to control. Dr. Reed has discovered the existence of physiological races or varieties of smuts. Varieties of the parasite that look exactly alike under the microscope may be quite different in their ability to infect a particular strain or variety of grain. These facts must be taken into consideration in breeding for resistance to smut infection. The smuts cause enormous losses in a great variety of cereals. The work that is being done here by Dr. Reed in cooperation with the United States Department of Agriculture is of very great scientific as well as of very great practical value in giving us increased power to protect our most important food crops.

The average annual loss to our crop plants caused by diseases alone averages 10 per cent., or more than $500,000,000 a year. All our botanical research in this field costs less than one tenth of one per cent. of the annual saving from the application of its results. A careful estimate made in 1928 covering about 40 years of research by the Bureau of Plant Industry of the U. S. Department of Agriculture in cooperation with

other agencies in the general field of applied botany showed an annual saving and gain of more than $500 for every dollar expended.

Let us move upward now on the ladder of life from the lowest forms of plant life to those organisms that are more commonly known as plants, *viz.*, those organisms that are green. They differ from the bacteria and fungi in that they are able to live normally only in the light. They draw their energy from the sun, utilizing it to combine carbon-dioxide with water, forming starch, sugar and cellulose, freeing bound oxygen in the process which adds materially to our slowly waning atmospheric supply. They then bring about combinations of sugar and nitrate or ammonia forming albuminoids and proteins, which are the basis of protoplasm, both in plants and animals. Plant and animal life, except the small group of bacteria able to obtain their energy from inorganic sources would be impossible without this fixation of carbon and transformation of energy carried on by green plants. Some of these green plants are so small that they are invisible to the unaided eye, single cells no larger than some of the bacteria. These are the simple algae, furnishing foods for other forms of microscopic aquatic animal life, which in turn are the food of forms of increasing size and complexity, and finally for oysters, lobsters, crabs and fish and other forms of aquatic animal life. Others are banded together into great masses of surprising beauty, like the sea weeds. Others are the grass of the field, which "to-day is and to-morrow is cast into the oven" or dies down to enrich the soil for the corn and wheat, the vine and the fruit tree or the great trees of the forest.

Plants are the great soil-builders and protectors of soil from wind and water erosion. Where we have destroyed vegetation planlessly and thoughtlessly we are rapidly losing our soil by wind erosion in dry periods and by water erosion in wet periods. In the last few years the topsoil on millions of acres west of the 100th meridian has been blown away in dust storms. Millions of acres have been covered by wind-blown sand. This is largely the result of overgrazing and consequent destruction of the plant cover or destruction of the plant cover by breaking up the sod to prepare the land for wheat or other crops. The danger has been appreciated by botanists and agriculturists for many years. But their warnings have not been heeded. Experiment stations established in this dryland area two decades ago have studied these problems and have pointed out safe uses for these lands, but lack of general appreciation of the danger has prevented general adoption of the methods recommended. The situation is now so serious that the whole nation is awake to it. Our botanists, ecologists and agriculturists are striving to find soil-binding plants and methods of checking erosion and in a measure repairing the damage. Botanical explorers are visiting various parts of the world to find additions to our store of drought-resistant and soil-binding plants to aid in this recovery program. Many valuable wild and cultivated species are being introduced. Botanic gardens furnish extremely valuable help in this and other plant introduction work.

In the areas formerly forested a similar process of unwise destruction of the forest cover has been going on for many years. Land of little or no value for agriculture has been denuded of its trees through destructive lumbering followed by fire. The exposed soil has been washed into the streams, choking their channels. Heavy rains are followed by floods. Navigation and power resources are destroyed. The aquatic plants are destroyed, followed by the animal life, fish and game when their primary food source is gone. The whole balance of nature is thus upset. What was once a source of wealth, and under proper use would have continued to be such, is rapidly becoming a barren waste and a source of danger. The indiscriminate dumping of sewage and industrial wastes into streams, lakes and the ocean is rapidly destroying aquatic vegetation of all types beneficial to aquatic animal life and the source of their food supply. Oysters, clams, crabs, fish and waterfowl disappear with their food supply. The public does not yet understand this danger to our great natural aquatic resources, and destruction still goes on. Here is a great field for the botanist and zoologist to do effective research and educational work. It is encouraging to note that the Secretary of War has appointed a committee to look into this pollution problem.

A program of erosion control has been recently inaugurated in a large way, and reforestation, range control on the public domain and land use programs are now matters of national concern. Intelligent plans are being made to correct these maladjustments as rapidly as possible. Botanical knowledge and research are the keys to the solution of these great problems. In this new era botany in its broad sense will be called upon to play an increasingly important part in the reestablishment of biologically balanced areas. The ecologists and physiologists have a large part to play. The plant explorers have important contributions to make. The phytopathologists must be on the job. There is work for the expert systematists, the algologists and bacteriologists, as well as foresters and agronomists. In all this work botanic gardens and arboretums will prove to be of increasing value.

With careful study and planning we shall be able in many cases to improve on the former natural vegetation. In many cases we shall use our rapidly increas-

ing knowledge of genetics to breed and fix better varieties and strains of plants better adapted to special uses —plants that are more resistant to drouth and cold, more firmly and deeply rooted, more resistant to disease and insect pests, and of better or more desirable quality for uses to which they may be put. All these things are now being done by botanists. Gradually through botanical study we have learned some of the secrets of making new varieties and species and establishing and even patenting some of them.

The plant breeder could not exercise this power to produce and establish new varieties with the efficiency now attained had not the student of genetics made available a large fund of information in this special field of research. The story is a long one, starting with the discovery of the sexuality of plants by Camerarias in 1691. Probably the most important discovery was that of Gregor Mendel more than a century ago in regard to the law of the distribution of unit characters in the progeny of hybrids. With improved technique and equipment it is possible now to connect certain characters of the progeny with the genes (the heredity units) of the chromosome controlling those particular characters. It may be possible in the future to more definitely control the combination of different genes to produce the new varieties of plants, having the combination of the characters desired. This is now accomplished by crossing large numbers of individuals having the unit characters desired, then selecting and recombining until the desired result is obtained. By taking advantage of the Mendelian formula, the fixed strains of the desired type if produced may be segregated in three generations, provided further crossing is eliminated. By using these methods the rust and drouth resistance of macaroni wheats (*Triticum durum*) have been successfully combined with *T. vulgare*, the ordinary bread wheat. At the wheat-breeding station at Omsk, Russia, the bread wheats have been successfully crossed with a wild grass, *Agropyron elongatum*, transmitting drouth, rust and alkali resistance to the progeny. Wilt resistance of the citron has been bred into the watermelon. The resistance of certain Asiatic chestnuts to chestnut blight has been bred into the American chestnut. Almost every variety of cultivated crop has been improved in one or more particulars by plant breeders. Some fine work of this kind is in progress here. Dr. Graves, of the staff of this garden, for several years has been collaborating with the Federal Department of Agriculture in producing hybrids between the American and Japanese and Chinese varieties of chestnuts, with a view to producing a tree which will not only be immune to chestnut blight, which has almost exterminated the American chestnut, but will also be a valuable timber tree. The results strongly indicate that this much-desired objective will be accomplished. Botanic gardens and arboretums are especially valuable as sources of breeding material and as centers where such studies can be carried on. They are among the most important sources of living plant material and are invaluable centers of technical and practical information in every phase of botanical study in its broadest sense. We need more of them and we should give them better financial support. Aside from their generally recognized practical value, they have great civic and educational value especially to the community in which they are located. Another line of development is the artificial production of mutation (inheritable variation not the direct result of crossing) by exposing the reproductive cells to x-rays and similar types of radiation. Profound changes are produced in this way.

Dr. Gager, the director of the Brooklyn Botanic Garden, shortly before coming to Brooklyn conducted extensive pioneer studies on the effect of the rays of radium on the various life processes of plants, and since coming to Brooklyn he has collaborated with Dr. Blakeslee, of the Carnegie Institution of Washington, in exposing reproductive cells to radium rays. The result of this work was to produce probably for the first time inheritable changes in living organisms by exposing their living cells to penetrating radiation. It is epoch-making work and is a field worthy of most careful study. Then there is the newly discovered mode of germplasmic origin of new characters *aristogenes*, of which at present we have no control.[2]

By varying the length of exposure to light and by modifying the wave-lengths of the light used or by increasing or decreasing the intensity of the total light and modifying the periods of exposure we can produce profound changes in the time of flowers and fruiting. This method of control has already proved to be of great value in plant breeding in the control of flowering periods and it may have much wider use, especially in plant introduction and adaptation. Changes in chemical composition, especially the vitamin content, may be brought about by light control. This vitamin content of plant tissue is especially important. The vitamins appear to be of the nature of vegetable hormones, certain of them controlling growth in animals; others control lime assimilation, reproduction and resistance to disease. This is one of the most productive and active fields of plant physiological, biochemical and biophysical research at the present time. It is opening a new field of nutrition and health preservation and control and prevention of some of the most serious diseases of man and other animals, such as tuberculosis, beriberi, scurvy, rickets, xerophthalmia, pellagra, rheumatism and others.

[2] SCIENCE, n. s., 80: 2087, 604, December 28, 1934.

The ultra-violet rays are principally involved in vitamin formation. These rays are largely eliminated by ordinary glass. Leafy field crops, like lettuce, grown under ordinary glass, should therefore receive supplementary ultra-violet light treatment if their vitamin content is to be up to normal. Special glass transmitting these rays is now available but at considerably increased cost. Special ultra-violet light radiation equipment is also available.

The environmental, nutritional and genetic factors controlling the production in the plant of other valuable organic constituents—gums, oils, fats, alkaloids, rubber—are still very imperfectly understood and offer a productive field of great scientific and economic value. Here again botanic gardens and arboreta afford the most helpful aids to such investigations. Time does not permit multiplication of examples of how botany, a knowledge of plant life, in one way or another enters into almost every aspect of our welfare. The time allotted might easily be consumed in the more detailed presentation of some narrow field, but I have selected the more general and less technical presentation so that those of you who are not botanists may get the broader perspective of the relation of botany to human welfare.

In closing this presentation I wish to give you an illustration of the importance of intensive study of problems that may appear at first sight to have no possible value to humanity. Botanists, as well as other scientists, are frequently criticized for devoting too much time and money to what the critic considers to be quite useless and worthless but which may later prove of very great value. There are numberless examples. I have time to call your attention to but one in which the Bureau of Plant Industry of the U. S. Department of Agriculture found uses for an apparently unimportant discovery made by Karl Wilhelm von Nägeli, a brilliant Swiss botanist. Von Nägeli, desiring to study under the microscope the activities of living plant cells, selected for the purpose what is popularly known as "frog spittle" or "green slime," a fresh-water alga belonging to the genus *Spirogyra*. This alga grows in ponds and slow streams and looks to the naked eye like fine, long, green silk threads. The microscope shows that the thread is made up of large cylindrical cells attached end to end, having spiral bands of chlorophyll. The protoplasm and nucleus show clearly. It is thus easy to see the living cell in operation. This, of course, was the reason for selecting this plant for study. It might not have appealed very strongly to the visiting committee of farmers and business men or the president of the university had they happened in at that time. They probably would have been more disgusted than was Nägeli himself when he could not get the alga to grow in his carefully prepared synthetic solutions, containing everything needed by the alga in just the right proportions. Day after day he tested and retested to find the reason why the *Spirogyra* died in his aquarium but would live in the water brought in from the pond containing the same nutrient salts. In his synthetic solutions made up from distilled water and from tap water, the *Spirogyra* after a few hours turned brown, broke up into short pieces and in twelve to twenty-four hours was dead. To make a long story short he finally traced the cause of death to minute traces of copper taken up from the bronze faucet in his laboratory as the water passed through it. The amount of copper was so small that it could not be detected by any chemical method known. But the chlorophyll band in the *Spirogyra* cell reacted to one part of copper in 50 million parts of water. It thus proved to be the most sensitive test known for copper. He described his researches and published them in a little pamphlet which remained untranslated and almost forgotten for more than half a century.

The next chapter in the story opens with a letter received by the Department of Agriculture from a cress grower, who complained that he and other growers were being put out of business by some disease attacking the cress. As this was quite an important industry in which many millions of dollars were invested, we sent Dr. George T. Moore to investigate. He found that the trouble was caused by *Spirogyra* smothering the cress. He thought right away of the work of Nägeli and made arrangements to add copper, 1 part to 50 million, to the water in some of the beds. It worked exactly as Nägeli has described. The Spirogyra was destroyed without injury to the cress. The cost was negligible. This led to a further study in the use of copper in destroying algae of various kinds in water reservoirs. Certain forms of alga growth make water almost impossible to use at certain times of the year, due to bad taste and odor imparted to it. Methods were worked out making it possible by treatment with copper to remove any of these contaminating species at small expense. The methods developed have now become standard sanitary engineering practice.

The next development grew out of the observation that in these copper-treated waters certain species of bacteria were greatly reduced in numbers. These belonged to the *colon* group. Tests were therefore made on typhoid, para-colon, Asiatic cholera and related species. It was found that these could be destroyed in a few hours by the introduction of small amounts of copper sulfate or metallic copper without the slightest danger to those using the water. Certain types of fish, however, were killed. This led also to the testing of chlorine for these types of bacteria.

Chlorine was found to be effective in destroying bacterial pollution without injury to fish but did not destroy algae. Both methods have now become standard practice in sanitary engineering.

The next development grew out of the observation that mosquito larvae were killed by these traces of copper, 1 part to 10 million. Colonel Gorgas requested that we send one of our men with him to clean up the zone in the Isthmus of Panama through which we were to dig the Panama Canal. The late Karl Kellerman was assigned to the job and used the copper treatment exclusively in destroying algae and mosquito larvae when it was not practicable to use oil.

The use of copper in water supplies was followed by a study of copper in animal nutrition. The results of that study show that it is absolutely essential along with iron for haemoglobin formation in the red-blooded animals. Its absence in the diet brings on secondary anemias that result in death if copper is not supplied. A trace of copper also proved to be essential in the growth of plants. What the next chapters will be I do not know. But I do know that Nägeli's work on "frog spittle" paved the way for work of very great value to humanity many years after he had passed away.

We must encourage and support research in all fields. It is the only key to progress. Botanical research has made it possible to produce food sufficient for earth's teeming millions if they will stop fighting and intelligently use the knowledge already gained.

In conclusion, I am sorry that the last annual report of the Brooklyn Botanic Garden did not come to my attention before I prepared my address for this evening. A discussion of that report would be a forceful presentation of botany and human affairs. The Brooklyn Garden is outstanding among the gardens of this country in its public relations contacts and in its cooperation with civic agencies of city, state and nation, in educating the public to appreciate the value, to the community, of botany in its many aspects and relations. Director Gager has been selected as chairman of the subcommittee having in charge this aspect of the plans for the National Botanic Garden at Washington.

THE ABSORPTION OF SOUND IN GASES[1]

By Professor VERN O. KNUDSEN

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THE experiments I shall here describe, which began with studies in architectural acoustics, have led to the discovery of important, although peculiar and unsuspected, laws concerning the propagation of sound in the atmosphere and other gases.[2] The results obtained also conform remarkably well with predictions of modern theories of the dispersion and absorption of sound in gases. In this latter connection the results exhibit a new technique for investigating the nature of energy transfers during molecular collisions.

The classical theories of Stokes and Kirchhoff on the absorption of sound in gases were based upon the effects of viscosity and heat conductivity, and until recently it has been assumed generally that these effects accounted for the observed attenuation of sound in the air and other gases. These classical theories, which require the attenuation to increase with the square of the frequency, explain, qualitatively at least, why, when listening to distant echoes of speech, we hear only the low-frequency vowels and do not hear the high-frequency consonants, which are absorbed in the air before reaching our ears. However, certain acoustical phenomena, which nearly every one must have observed in his early youth, are not even qualitatively explained by these classical theories. Thus, the sound of an approaching train or a wagon coming over a cobblestone road can be heard more distinctly and at a greater distance when a storm is gathering (usually characterized by a drop in temperature and an increase in humidity) than when the air is warm and relatively dry; and the sounds of ordinary speech can be heard at distances of more than a mile on cold, dry days. Reliable observations of such Arctic explorers as Stefansson indicate that at $-80°$ F. conversations as far away as five or six miles have been heard and understood, and that other sounds, as the barking of dogs or the chopping of wood, have been heard at distances as great as fifteen miles. These long distance transmissions of sound through the atmosphere are usually explained by assuming that the temperature of the air increases from the ground upward—often referred to as an inverted temperature gradient—which would cause the sound waves to be refracted downward and thus spread out essentially in two dimensions over a wide horizontal zone; whereas, under the more common condition of

[1] At the request of the editor of SCIENCE this non-technical article has been prepared by the author of the paper presented at Pittsburgh to which was awarded the prize for a notable contribution presented at the annual meeting of the American Association for the Advancement of Science.—ED.

[2] The experiments are described more completely in papers in the April (1935) issue of the *Journal of the Acoustical Society of America*, and in previous issues of this journal.

a decreasing temperature from the ground upward—referred to as a normal temperature gradient—the sound waves are refracted upward and thus are not heard at great distances by observers on the ground. Although temperature refraction is an important factor in explaining the propagation of sound in the atmosphere, it is not sufficient to account, for example, for the observed differences of sound transmission in temperate and frigid zones, since the air may be characterized by an inverted temperature gradient in both zones; and, as we shall see, the acoustical "transparency" of the air is greatly dependent upon both temperature and humidity.

The modern theory of the absorption of sound in gases began with a paper by Jeans in 1904, and has been developed into a useful form by the contributions of Einstein in 1920, Hertzfeld and Rice in 1928, and Kneser and others since 1931. The work of Kneser,[3] the theoretical part of which was modeled after the treatise by Einstein, not only led to convenient equations for calculating the velocity and absorption of sound in gases, but was followed by an experimental study on the velocity of sound in CO_2 which gave results in good agreement with his dispersion formula.

In the simplest form of this modern theory, such as is here sufficient to account for the observed absorption in air and oxygen, it is assumed that there are only normal or non-vibrating molecules, and one kind of vibrating molecules having a characteristic frequency and a characteristic "life time" (average duration of a quantum of vibration). The theory shows that the absorption coefficient per wave-length is

$$\mu = 2\pi \left[\frac{RC_i}{C_\infty(C_\infty + R)} \cdot \frac{\omega k_{10}}{k_{10}^2 + \omega^2}\right] \tag{1}$$

where R is the gas constant, C_∞ is the heat capacity of the gas for sound of infinite frequency, C_i is the internal heat capacity, ω is 2π times the sound frequency and k_{10} is a reaction constant which gives the number of transitions from the excited to the normal state per molecule per second. The maximal value of the absorption coefficient μ_m occurs when $k_{10} = \omega$, so that

$$\mu_m = \pi \left[\frac{RC_i}{C_\infty(C_\infty + R)}\right] \tag{2}$$

From (2) it is seen that the maximal absorption, which occurs when $\omega = k_{10}$, is a constant which, for a certain gas, depends only on C_i and C_∞, and that the maximal absorption coefficient per unit length $m_m = \mu_m/\lambda$ (where λ is the wave-length) is proportional directly to the frequency. Further, it is evident from (1) that in order to determine the reaction constant k_{10} either for a pure gas or a gas mixture it is necessary only to determine the frequency at which the absorption is a maximum.

Before the above theory had been fully developed, the author's attempt to calibrate a new reverberation chamber revealed that the absorption in air at ordinary temperatures and humidities was very much greater than the value predicted by classical theory, and depended upon humidity and temperature in a characteristic manner. These results were obtained by measuring the rate of decay of sound in two similarly shaped rooms, having the same boundary material (painted concrete) and containing air of the same temperature and humidity, but having different "mean free paths" (the average distance the sound waves travel between successive reflections).

The success of the initial two-room experiment suggested the desirability of using smaller chambers in which the temperature and humidity of the air could be more easily controlled, and in which other gases could be investigated. Accordingly, a six-foot cubical chamber and a two-foot cubical chamber were constructed from one fourth inch steel boiler plate, strengthened with angle iron, spaced two feet on centers. The chambers are equipped with rotating paddles which keep the sound in a diffuse state. The source of tone is a high frequency loud speaker actuated by a pure sine wave alternating current from an audio-frequency oscillator. The rate of decay of sound in the chamber is measured by a specially designed reverberation meter consisting of an electrodynamic microphone, amplifier, attenuator, rotating contacts and neon lamp indicator.[4]

Figure 1 shows the results of a series of measure-

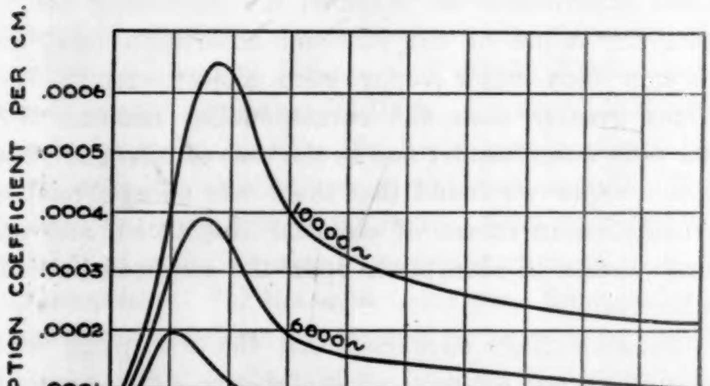

FIG. 1. Curves showing the absorption coefficient of sound in air for different relative humidities at 20° C. Note that for each sound frequency there is a certain humidity at which the absorption is a maximum.

[3] H. O. Kneser, *Ann. d. Phys.*, 11: 761–801, 1931; *Jour. Acous. Soc.*, 5: 122–126, 1933.

[4] The apparatus is described in an article by the author in the *Jour. Acous. Soc.*, 5: 112–121, 1933.

ments on the absorption of audible sound in air for different relative humidities at a temperature of 20° C., for frequencies of 1,500, 3,000, 6,000 and 10,000 cycles. It will be noticed that for each frequency there is a certain humidity at which the absorption is a maximum. Further, the magnitudes of these maxima are proportional directly to the frequency and *not* to the square of the frequency, as is required by classical theory. Also, the magnitude of the absorption at any frequency or humidity is greatly in excess of the amount predicted by the classical theory—the observed absorption is of the order of 10 to 100 times greater than the classical absorption. For example, at a relative humidity of 18 per cent. and for a frequency of 10,000 cycles, the absorption (or attenuation) coefficient is 0.00065 per cm, or 0.020 per ft. Hence, such a plane wave would have its intensity reduced to $\frac{1}{e}$ of its initial intensity after traveling a distance $\left(\frac{1}{0.020}\right)$, or 50 feet. This is equivalent to a rate of decay of 96 db per sec., or 450 db per mile—a rate of decay which is in excess of the most desirable rate of decay for good acoustics in auditoriums, and which is so high as to exclude the possibility of using tones above, or even near, this frequency for long distance signaling in the air.[5]

Having determined the nature and magnitude of the very high absorption of sound in air containing different amounts of water vapor, the investigation was continued in the direction of ascertaining whether the oxygen, nitrogen or some other component of the air were responsible for the anomalous absorption. Accordingly, measurements were made in oxygen plus water vapor and in nitrogen plus water vapor. In these experiments we obtained the interesting result that the values of the maximal absorption (μ_m) in oxygen plus water vapor were almost exactly five times greater than the corresponding maxima for air plus water vapor; and in the case of nitrogen plus water vapor we found that there was no appreciable absorption in excess of classical absorption, and no dependence of absorption upon the concentration of water vapor.

These findings suggested that the absorption was almost, if not entirely, attributable to the oxygen in the air; and in fact, Dr. H. O. Kneser, who was then at the University of California, showed that the results were in good agreement with Eqs. (1) and (2) provided the absorption resulted entirely from energy transfers between oxygen molecules and provided further that the reaction constant k_{10} were a quadratic function of the concentration of the water vapor. Water vapor is the only gas we have worked with which, when added to oxygen, obeys this quadratic relation; for all other impurities the reaction constant is a linear function of the concentration.

The above measurements in air and in oxygen were made at a temperature of 20° C. At a temperature of 55° C., the absorption in air and oxygen, containing small amounts of water vapor, reached maxima which were approximately twice as large as those obtained at 20° C. This result is in good agreement with the predicted values based on Eqs. (1) and (2).

On the other hand, measurements in air at − 15° C. indicated that there was practically no absorption at this temperature—certainly not much more than the classical absorption—and there was no measurable variation of absorption with humidity.

These experiments at different temperatures and humidities explain, in part at least, why sounds are transmitted over such great distances in the cold, dry air of the Arctic, and why similar sounds are stifled in the hot desert air, which so often has just the required humidity to give maximal absorption. All problems associated with the propagation of sound in the atmosphere must reckon with this anomalous absorption. I shall mention only two typical problems: (1) for a given temperature and relative humidity of the air there is an optimal frequency for long range sound signaling, usually not more than 2,000 cycles per second; and (2) in the reproducing of sound in large theaters, and especially in the out-of-doors, selective amplification, in amount and character dependent upon temperature and humidity, should be given to the high frequencies.

The good agreement between the observed and calculated values of the absorption of sound in oxygen plus water vapor indicated that similar absorption measurements in pure or mixed gases should provide an effective means for investigating energy transitions during molecular collisions. Accordingly, Kneser and the author undertook a series of experiments on the absorption of sound in oxygen containing known amounts of gaseous impurities.[6]

The results of these experiments show that the reaction constant k_{10} for O_2 is strongly influenced both by the kind and amount of gaseous impurities, a conclusion which for other gases had been previously reached from dispersion measurements at supersonic frequencies by Richards and Reid and by Eucken and Becker.

Kneser has calculated the collision frequencies and the probabilities of transitions between excited and normal oxygen molecules for the different gaseous im-

[5] These problems are discussed at greater length in the article referred to in footnote 4.

[6] Kneser and Knudsen, *Ann. d. Phys.*, 21: 682–696, 1935.

purities in oxygen with which we have worked.[6] From these calculations it is found that when an excited oxygen molecule collides with an alcohol molecule the probability is slightly better than 1 in 1,000 that the vibrating oxygen molecule will lose its vibrational energy. This probability of transition is of the order of 5,000 times the probability of transition in collisions between two oxygen molecules. This probability of transition decreases progressively, and in the order named, for impurities of ammonia, benzene, water vapor, acetylene, hydrogen sulfide, carbon tetrachloride, carbon monoxide, hydrogen, carbon dioxide, nitrogen, helium and oxygen. A collision between two oxygen molecules is thus seen to be the least probable type of collision for producing transitions between normal and excited oxygen molecules. It also appears that hydrogen molecules are more effective than helium molecules for producing transitions.

As yet, insufficient data are available to offer a complete explanation of the collision process. However, a number of tentative assumptions are suggested by the data obtained to date.[6]

(1) The simple impulse theory of the transfer of energy at collision is inadequate, since hydrogen, for example, is more effective than the heavier helium.

(2) If an oxygen molecule collides with a molecule having a dipole moment, the collision is more likely to disturb the nuclear vibrations of the oxygen molecule than is the case in a collision with a molecule which has no dipole moment. Thus, our data indicate that carbon monoxide is more effective than the similar nitrogen molecule.

(3) Our results would seem to support the suggestion of Eucken and Becker that a strong disturbance should be expected if the collision partners have a high chemical affinity.

In conclusion, the experiments described in this paper indicate that the measurement of sound absorption in gases provides a new approach to a number of important problems related to molecular collisions. In addition, the absorption measurements in air are of general interest to the most casual observer. They not only clarify a large number of curious problems associated with the influence of the weather on the acoustics of the atmosphere, but they have an immediate and practical application in architectural acoustics and sound signaling.

OBITUARY

HUGO DE VRIES

1848–1935

ON May 21, in the little Dutch village of Lunteren, a kindly old man in his eighty-seventh year died, and the news was cabled to all parts of the civilized world. The passing of Hugo de Vries brings to a close a life rich in achievement.

De Vries was a botanist, but his early work on turgor in plants influenced the development of chemical theory. By means of the plasmolytic method he determined the relative influence of molecular solutions of various salts and organic compounds upon osmotic pressure of the cell sap and expressed these differences in terms of his isotonic coefficients. It was upon these studies that Van't Hoff and Arrhenius based their laws of disassociation in dilute solutions which form one of the fundamental concepts of physical chemistry.

De Vries is most widely known, however, for his influence on biological thought. In 1889 he published his theory of intracellular pangenesis, in which, on the basis of extensive observations, he argued that hereditary particles corresponding to the different adult characters must be present in all cells of the organism. This is an early statement of our modern concept of the gene. In his foreword to Gager's translation of "Intracellular Pangenesis," Strasburger writes as follows: "By creative imagination Hugo de Vries predicted much in his book that gained a material basis only through the histological research of the following decades . . . he predicted phenomena which were to furnish the basis for our conceptions of fertilization and heredity but which have become actually known to us only through later works on the most intimate processes of nuclear division." His powers of prophetic imagination are also shown in an address delivered at the opening of the Station for Experimental Evolution in 1904. He urged that attempts be made to alter the hereditary particles in germ cells by application of external stimuli. He pointed out that x-rays and radium have been found capable of bringing about important changes in living organisms. "If the same holds good for our dormant representatives in the egg we may hope some day to apply the physiological activity of the rays of Röntgen and Curie to experimental morphology." It was nearly a quarter of a century before this hope of de Vries was realized.

De Vries was the outstanding figure in the biological world in the early part of this century when genetics was being born and new and revolutionary ideas were appearing in rapid succession. More than any other man he helped to lead biologists from the speculative age of Darwin into an age of experimen-

tation. He was the first of the three in 1900 who announced the discovery of the laws of Mendel from their own independent investigations. His name is more closely associated, however, with the mutation theory which he announced in 1901. In this, from study of a wealth of material, he was able to distinguish between fluctuating variations caused by the environment and changes due to the sudden origin of a new hereditary unit which he called a mutation.

In the evening primrose (*Oenothera Lamarckiana*) upon which the mutation theory was largely based, de Vries thought he had found a species in a state of rapid mutation to "elementary sp[illegible] The literature on the genetics of this form [illegible] the pen of de Vries and his followers has reached a large volume, but it is now agreed that most of its frequent mutations are not due to new hereditary units (or genes, as we now call them) but rather to alterations in genic balance brought about by changes in amounts of relatively large blocks of chromosomal material. This change in interpretation does not detract from the value of the mutation theory which was a tremendous stimulus to research and which has become firmly established from facts in a wide range of forms among both animals and plants.

The mutation theory alone appears to be an inadequate explanation of the origin of species, but if the study of evolution ever becomes thoroughly experimental, as there are indications may be the case, a large share in the credit will be due to Hugo de Vries.

De Vries was born in Haarlem on February 16, 1848. His doctorate was received from the University of Leiden in 1870. After study in German universities, he was called in 1877 to a lectureship in the University of Amsterdam, where later he was advanced to the professorship of plant physiology, a position which he retained until he retired in 1918 at the age of 70. Upon this occasion his papers were reprinted in a series of seven volumes entitled "Opera e Periodicis Collata." His later years were spent in Lunteren, Holland, where he had a small greenhouse and garden in which he continued his experiments on the evening primroses almost to the end. He three times visited this country: in 1904 when he helped to dedicate the Station for Experimental Evolution of the Carnegie Institution of Washington and gave a course of lectures at the University of California; in 1906 again to give lectures at the University of California and in 1912, when he came to give an address at the opening of the Rice Institute.

Among published photographs of de Vries and accounts of his life may be mentioned those by Lehman,[1] Almquist,[2] Shull[3] and the writer.[4]

Few scientists have influenced so profoundly the theory and experimental practice in their fields of research as did de Vries. He brought to bear upon his investigations a combination of mental qualities which are rarely developed to the same degree in a single individual. He was a keen observer, a patient accumulator of data, an untiring and meticulous experimenter, skilful in interpretation of evidence and yet able to relate his findings to broad problems of fundamental importance. He was a man of theory and vision as well as a gatherer of details in laboratory and garden, a pioneer and prophet. The name of Hugo de Vries will forever remain an inspiration to all biologists.

ALBERT F. BLAKESLEE

WILLIAM PARKER CUTTER

WILLIAM PARKER CUTTER, librarian of the Bermuda Biological Station for Research, died at the Massachusetts General Hospital on May 20, 1935, and was buried in Mt. Pleasant Cemetery, Arlington, on May 22.

Mr. Cutter had been connected with several scientific institutions and important libraries in the United States before assuming charge of the library of the Bermuda Biological Station. He was born at Washington, D. C., on December 19, 1867; graduated at Cornell University in 1888; was chemist at the Agricultural Experiment Station, Logan, Utah, from 1890–1893; librarian of the Department of Agriculture, Washington, from 1893–1900; chief of the order department of the Library of Congress, 1901–1904; librarian of the Forbes Library, Northampton, Massachusetts, 1904–11; librarian of the Engineering Societies, New York, 1911–17; manager of the book department of the Chemical Catalog Company, 1918–20; librarian, Research Library, National Aniline and Chemical Company, 1921–22; director of the information department, Arthur D. Little, Inc., 1922–27; assistant librarian, Baker Library, Harvard University, 1928–32; librarian, Bermuda Biological Station, 1933–35. He was a member of the American Library Association and secretary of the joint committee on Classification of Technical Literature, 1915–17. He was the author of "Rare Books and Their Values," 1903, and also of various articles on library topics.

In his last years Mr. Cutter's health was frail, and he sought relief from the extremes of the New England climate in the more equable climate of Bermuda, where

[1] E. Lehman, "Hugo de Vries, 6 Vorträge zur feier Seines 80. Geburtstages." Tübinger Naturw. Abhandl. 62 pgs. F. Enke: Stuttgart, 1929.

[2] Ernst Almquist, "Grosse Biologen. Eine Geschichte der Biologie und ihrer Erforscher." 143 pgs., J. F. Lehmann, München, 1931.

[3] G. H. Shull, *Journal of Heredity*, 24: 3–6, 1933.

[4] A. F. Blakeslee, *Scientific Monthly*, 36: 279–280, 1933. This article has been drawn upon in preparation of the present note.

he was appointed librarian of the new Bermuda Biological Station for Research. There he reorganized and in large part catalogued the books, journals and pamphlets already on hand, as well as about 600 newly acquired volumes, and some 20 journals and serial publications obtained by gift or purchase. He also superintended repairs to many old volumes that had suffered injury, and he devised ingenious means of protecting books from mould and the ravages of insects, which are such a serious menace to libraries in warm countries.

His most important service at the Bermuda Station consisted in planning and supervising the conversion of an unused power house, near the main building, into a well-lighted, commodious and fireproof library building and in equipping this and transferring to it the publications from the crowded quarters in the main building. On March 30 last the new library was formally opened by His Excellency, the Governor of Bermuda, in the presence of a distinguished company of scientists, officers and trustees of the station and other invited guests, and on that occasion tribute was paid to Mr. Cutter by the director of the station, Dr. J. F. G. Wheeler, the senior trustee in Bermuda, Honorable F. Goodwin Gosling and by Mr. Paul Vanderbilt, librarian of the Pennsylvania Museum of Art, a former pupil and associate of Mr. Cutter, who called him "one of the greatest librarians of the United States." Mr. Cutter was present and took part in the formal opening of the library, and it is a source of gratification to his many friends that he lived to see the consummation of his plans for the new library and to receive the tributes which were paid to him on that occasion.

Edwin G. Conklin

MEMORIALS

The trustees of Columbia University have voted to name the Astronomical Observatory the Rutherfurd Observatory, in honor and in memory of Lewis M. Rutherfurd, who was the first astronomer to introduce photographic methods of precision in the field of astronomy.

A tablet in memory of Dr. William H. Welch was unveiled on June 5 at the Happy Hills Convalescent Home for Children near Bellevue, Md. Dr. Welch was one of the founders of the home and its first and only president.

The state of New York, Schenectady County and Union College joined on May 29 in a memorial celebration for Dr. Franklin B. Hough, "Father of American Forestry," in simple ceremonies in the college building, where he first worked with "botanical and mineralogical specimens," for which he gave up the practice of medicine to crusade for the conservation of natural resources in New York and in the nation. An oil portrait of Dr. Hough, who died in 1885, was presented to Union College by J. P. Apperson, chairman of Governor Herbert H. Lehman's committee for celebrating New York's fifty years of conservation in Schenectady County. Dr. Willis R. Whitney, of the General Electric Company, and a trustee of Union College, was chairman of the exercises. Lithgow Osborne, state conservation commissioner; Mr. Apperson and Dr. Dixon Ryan Fox, president of Union College and a member of Governor Lehman's general celebration committee, spoke.

Marie Curie Avenue, New York City, which parallels the East River from Sixty-third to Eightieth Street, was officially dedicated on June 9 by Mayor F. H. La Guardia at the close of ceremonies attended by representatives of the Polish and French Consulates. More than 3,000 persons were present. The occasion marked the thirty-seventh anniversary of the discovery of radium.

A banquet in support of a British memorial to Madame Curie was held recently in London. The purpose was to raise $250,000 for the endowment and extension of the Marie Curie Hospital of London. Sir Neville Chamberlain, who took the chair, said that he had been asked to do so because of his long association with the ministry of health. Sir William Bragg was the principal speaker.

RECENT DEATHS

Adam M. Miller, dean of the Long Island College of Medicine, died suddenly at his home in Mountain Lakes, N. J., on May 28, 1935. He had been dean for fifteen years and professor of anatomy since 1914. During his tenure of administrative office he played a most important part in the reorganization of the college as it merged from the Medical College of the Long Island College Hospital into its present status. He was born in Homewood, Pa., on April 2, 1879. He graduated from Princeton, A.B., 1901, M.A., 1902, and remained there as a graduate fellow in biology under Edwin G. Conklin until 1903. He then joined the staff of George S. Huntington at the College of Physicians and Surgeons, Columbia University, where he continued his studies in embryology. It was there that he, in collaboration with Frederick R. Bailey, published the "Text-Book on Embryology." From 1903 to 1912 he was instructor in the department of histology and embryology at the College of Physicians and Surgeons, and from 1912 to 1914 was assistant professor of anatomy. He went to Brooklyn in 1914 as professor of anatomy at the Long Island College Hospital.

DR. BENJAMIN S. WARREN, from 1922 to 1934 medical director of the U. S. Public Health Service, died on May 20, at the age of sixty-three years.

JOSEPH THOMAS CUNNINGHAM, marine zoologist and biologist of the London Hospital Medical College, has died at the age of seventy-six years.

PROFESSOR GAETANO FICHERA, who was the director of the Milan Institute for Cancer Research, died on May 21. He was fifty-five years of age.

SCIENTIFIC EVENTS

THE MEDICAL CURRICULUM IN GREAT BRITAIN

THERE was published on May 17 the report of the conference of representatives, nominated by the Universities of Oxford, Cambridge and London, the Royal College of Physicians of London, the Royal College of Surgeons of England and the Society of Apothecaries of London, on the medical curriculum.

The members of the conference were: Lord Dawson of Penn (chairman), Professor Sir E. Farquhar Buzzard (chairman of the Executive Committee), Professor G. E. Gask (vice-chairman of the Executive Committee), Professor Sir Walter Langdon Brown, Dr. A. E. Clark-Kennedy, Sir Raymond H. P. Crawfurd, Professor Winifred Cullis, Professor H. R. Dean, Professor C. A. Lovatt Evans, E. L. Pearce Gould, Dr. A. M. H. Gray, Professor W. W. Jameson, T. Bramley Layton, Dr. M. H. MacKeith, Professor Sir Ewen Maclean, W. H. Ogilvie, Sir Holburt Waring and Professor W. Wright, with G. W. Rossetti as secretary.

The following are among the recommendations of the conference:

That the minimum length of the medical curriculum be not extended beyond the present period of five years.

Medical studies proper—*i.e.*, anatomy and physiology—should not be begun before the age of 18.

In view of the very considerable difficulties experienced by schools in teaching candidates for the requirements of the different syllabuses of the several examinations for 1st M.B. or basic sciences, the syllabuses in chemistry, physics and biology in the examinations for 1st M.B. or basic sciences of the different licensing bodies should be brought more into line one with another.

To ensure, during the period subsequent to passing matriculation, the continuance at schools of the general education of intending medical students, the licensing bodies should consider the possibility of allowing and encouraging exemption from the 1st M.B. examination by means of a higher school certificate examination conducted by any recognized examining body, in which, in addition to the three principal scientific subjects, a subsidiary non-scientific subject be taken.

During the first two years (six terms) of medical studies the work of the student should be arranged by a board of teachers representing anatomy, physiology, chemistry, biochemistry, pharmacology and pathology.

During the first four terms of medical studies the student should continue the study of chemistry, carry out work in the dissecting room and department of anatomy, and, in the second term, begin the study of elementary physiology and biochemistry.

During the fifth and sixth terms of medical studies, while continuing the study of anatomy and physiology, the student should be introduced to the principles of general pathology, immunology and bacteriology by a pathologist.

The teaching of organic, physical and colloidal chemistry should be determined by conference between the teachers of physiology, biochemistry and chemistry, due weight being given to the opinions of the teachers of physiology on the special needs of students of medicine.

The teacher of anatomy should be given access to hospital material for teaching applied anatomy, with or without the assistance of a clinician attached to his department.

During the second year of medical studies the teacher of physiology, being provided, if necessary, for this purpose with a clinical assistant, should give demonstrations in applied physiology and familiarize the student with the use of the stethoscope, the ophthalmoscope, the laryngoscope and the otoscope.

During the second year of medical studies the teaching of pharmacology, which shall include toxicology, should be arranged in close cooperation with the teachers of physiology.

During the second year of medical studies the student should attend a short course of lectures in elementary medical psychology.

THE PRESIDENT'S STATEMENT TO THE COUNCIL OF THE AMERICAN CHEMICAL SOCIETY

AT the meeting of the council of the American Chemical Society in New York City, on April 24, Professor Roger Adams gave the following summary of the work of the society to the one hundred and sixty-six councilors present at the meeting.

Since the beginning of 1934, the American Chemical Society has operated under a new plan of membership fees. In brief, individuals joining the society pay $9 for the privilege of membership and for the *News Edition*. A fixed additional sum is charged for each of the journals and members may select on this basis one or more of those desired. This procedure was introduced to accommodate those men who must consider their expenses carefully, and those who for one reason or another do not require all the society's pub-

lications. The detailed plans so carefully and skilfully developed by a committee of the society and adopted by the council have proved to be a very successful experiment. It has, Dr. Adams believes, operated to the satisfaction of practically all the membership and to the advantage of the American Chemical Society.

In 1932 and 1933 the society's income was insufficient to meet even the reduced budgets of those years. It is encouraging, therefore, that in 1934 the funds received were adequate, not only to handle all the financial obligations, but also to offset partially the rather substantial deficit of the previous year. The advertising revenue also improved. As a result of the somewhat larger income, the directors felt justified in increasing the publication appropriation in the 1935 budget so that the *Journal of the American Chemical Society* and *Industrial and Engineering Chemistry* might provide more effectively for the printing of material submitted by the members; and that *Chemical Abstracts,* which had been required to contract below the desirable minimum, might expand slightly its presentation of the chemical literature of the world.

Because of the difficult years through which the society has just passed, a few comparative figures on the membership and subscriptions are pertinent. To-day the total membership is 17,003. On April 1 of this year, there were over 1,800 $9 members, representing about a 25 per cent. increase in this group over last year. The maximum number of resignations came at the beginning of 1933, but each year since then the number has materially decreased; at that time, also, the number of new members and reinstatements was at a minimum but has increased regularly during the intervening period.

As of April 1, 1935, the *Journal of the American Chemical Society* and *Chemical Abstracts* have each received subscriptions amounting to over 300 more than last year and *Industrial and Engineering Chemistry,* to over 800 more. The total subscriptions of all paid members and non-members to the three publications at present is over 9,100 for the *Journal of the American Chemical Society,* over 11,500 for *Chemical Abstracts* and over 14,700 for *Industrial and Engineering Chemistry.* The *News Edition* enjoys the largest circulation of any magazine going to chemists—18,616. All indications point to a healthy condition of the society; all curves point upward.

Of the various committees of the society appointed last year, one of special interest because of its particular objectives may be mentioned. It has been actively engaged in studying the requirements of courses in education for chemists before they are eligible for teaching positions in high schools.

During 1934 the unemployment problem has received special attention. In addition to the free advertisement in the employment information pages of the *News Edition,* the activities of several of the local sections and the aid which is given through the secretary's office in placing before employers the names of unemployed, a committee of the society, with an appropriation for necessary expenses, has been attempting to determine the actual unemployment conditions among chemists and to point out how the society might cooperate to alleviate them.

The problem is a complicated one and extends beyond the attempt to find vacancies for those out of work. It involves a consideration of the training of the individuals as demanded by industry and the personal qualifications of those unemployed. It is recognized by all that the American Chemical Society can not directly create positions for chemists. It can and has devoted untiring effort to make the nation chemically conscious and thus indirectly to stimulate the industries to an appreciation of what contributions the chemist may make in a wide variety of fields of endeavor. Cooperation of the many efficient local agencies and of the national society in devising methods for aiding the unemployed should unquestionably lead to improved conditions.

INSTITUTIONS SELECTED FOR WORK BY FELLOWS OF THE NATIONAL RESEARCH COUNCIL

THE National Research Council has issued a bulletin giving the results of an inquiry into the institutions selected by research fellows in physical science at which to carry on their work. These results, with special reference to the situation at Princeton University, are summarized in the *Alumni Weekly,* in part, as follows:

National Research Council grants are given only to holders of the Ph.D. degree. Certain men divide their time among two or more universities, and in the following tables each institution has been credited as if the individual had spent his entire time there. Fellows in mathematics are accredited jointly to Princeton University and to the Institute for Advanced Study, the mathematics divisions of which cooperate in many phases of graduate work.

Chicago continues in first place in the matter of training men who are to be awarded National Research Council fellowships, but Princeton is close behind. For the three branches of science, future winners of fellowships have received Ph.D. degrees from the following universities, among others:

PLACE OF GRADUATE TRAINING

Past and Active Fellows

Chicago	45	Wisconsin	23
Princeton	43	Yale	22
California	37	Columbia	16
Harvard	35	Cornell	16
C. I. T.	31	M. I. T.	14
Hopkins	31	Michigan	14

Princeton has undisputed first place on a list of the institutions at which the fellowship-holders elected to study. These are the figures for certain of the leading institutions in the three sciences:

PLACE SELECTED FOR ADVANCED RESEARCH
Past and Active Fellows

Princeton	104	Hopkins	17
Harvard	85	Yale	15
C. I. T.	79	Wisconsin	12
Chicago	52	Cornell	9
California	40	Columbia	8
M. I. T.	33	Michigan	8

The two tables above can be combined to give an approximate statement of the universities' standing. There are rarely duplications between the two lists:

COMBINED TABLE
Past and Active Fellows

Princeton	147	M. I. T.	47
Harvard	120	Yale	37
C. I. T.	110	Wisconsin	35
Chicago	97	Cornell	25
California	77	Columbia	24
Hopkins	48	Michigan	22

Counting only the fellows active at the present time, Princeton also enjoys first position, indicating that the record of the past is being maintained.

COMBINED TABLE
Active Fellows

Princeton	18	Wisconsin	5
Harvard	12	Chicago	4
California	11	N. Y. U.	4
C. I. T.	11	Columbia	3
M. I. T.	11	Cornell	3
Hopkins	8	Brown	2
Illinois	6	Iowa	2
		Yale	2

California has the best record in physics among this year's fellows, three of its doctors holding fellowships at other universities, and four men from elsewhere having elected to study at Berkeley. Second place in physics this year goes to California Institute of Technology, and third to Massachusetts Institute of Technology. Princeton, New York University and Wisconsin are tied for fourth.

The Massachusetts Institute of Technology is first in chemistry and is followed by California Institute of Technology, Harvard, California, Princeton and Wisconsin.

In mathematics Princeton is followed by Brown, Harvard, Hopkins and Chicago.

ENGINEERING IN THE SUMMER SESSION OF COLUMBIA UNIVERSITY

DURING the thirty-sixth Summer Session of Columbia University, which begins on July 8 and continues until August 16, instruction will be given in chemical, civil, drafting, electrical and household engineering.

Professor Arthur W. Hixson will be in charge of work in chemical engineering. With Professor Lincoln T. Work he will supervise a chemical engineering laboratory in which a thorough experimental study will be made of the basic operations employed in chemical manufacturing plants. Professor William D. Turner will conduct a course in the Chandler Laboratories on the application of chemistry in industry. Industries producing chemicals, using chemical methods or involving chemical control of process will be studied. The course is also designed for teachers of general chemistry in high schools and colleges who wish an up-to-date knowledge of practical chemistry as a means of bringing greater human interest into their teaching. Research work will be carried on in the laboratories by advanced students under the direction of Professors Hixon, Work and Turner.

Camp Columbia, at Lakeside, Conn., will be the headquarters for students of civil engineering, who will be under the direction of Professor James K. Finch. A lake adjoins the camp cabins, which are situated in the hills on a ten-acre tract.

Work in electrical engineering will be carried on by Professor F. W. Hehre, while the engineering drafting work will be under the supervision of Professor C. H. Schumann, Jr., who will have charge of engineering drafting. Descriptive geometry, statistical drafting and mechanical drafting will also be studied in this division.

Household engineering, dealing with the fundamental principles of mechanics, heat and electricity and their applications to the home, as well as a course on simple tests of household appliances, will be directed by Professor Carleton J. Lynde, of the department of physics.

A special series of lectures by Dean Joseph W. Barker, of the Columbia School of Engineering, and others will deal with "Science and Mathematics in Engineering." The lectures will be designed to assist teachers in their work of counseling with high-school students concerning vocational careers. Specialists will represent each of the major fields of engineering.

SCIENTIFIC NOTES AND NEWS

THE degree of doctor of science was conferred on June 4 at the commencement exercises of Columbia University on William Slocum Barstow, electrical engineer, and on Harvey Fletcher, electrical engineer and director of acoustical research in the Bell Telephone Laboratories.

At the one hundred and sixty-ninth commencement of Rutgers University Admiral Richard Evelyn Byrd was granted the honorary degree of doctor of laws in recognition of his "valor in exploration."

At the commencement of the University of Pittsburgh on June 5, the honorary degree of doctor of science was conferred on William A. Hamor, assistant director of the Mellon Institute of Industrial Research.

Stevens Institute of Technology at the sixty-third annual commencement exercises conferred the degree of doctor of engineering on John Castlereagh Parker, president of the Brooklyn Edison Company, formerly professor of electrical engineering at the University of Michigan; on Adolf Meyer, director of the Steam Turbine Department of Brown, Boveri and Company, Switzerland; on Robert C. Stanley, president of the International Nickel Company, and on Walter Kidde, president of Walter Kidde Constructors.

Dr. John M. T. Finney, professor emeritus of surgery at the Johns Hopkins Medical School, received the honorary degree of doctor of laws at the commencement exercises of the Tulane University of Louisiana.

At the one hundred and thirteenth annual commencement of the Philadelphia College of Pharmacy and Science, held on June 5, honorary degrees were conferred on Dr. William A. Pearson, dean of the Hahnemann Medical College of Philadelphia; on Eli Lilly, president of Eli Lilly and Company, and on John M. Woodside, member of the Pennsylvania Board of Pharmacy and long a retail pharmacist in Philadelphia.

Professor William G. Owens, of the department of chemistry of Bucknell University, who retires after serving for fifty-five years, was the guest of honor at a formal dinner on June 7, at which President Homer P. Rainey presided.

A testimonial dinner to Dr. J. G. Lipman, dean of the College of Agriculture of Rutgers University and director of the New Jersey Agricultural Experiment Station, was held in New Brunswick, N. J., on June 5, by the members of the department of soils and crops and the editorial staff of *Soil Science* in commemoration of his twenty years as editor-in-chief of this journal, which he founded in 1915. The first number of Volume 40, which is dedicated to Dr. Lipman, includes articles concerned with his achievements in soil science and his influence upon research in this field. Papers were contributed by Sir John Russell, Rothamsted Experimental Station, England; Dr. S. A. Waksman and Professor A. W. Blair, New Jersey Agricultural Experiment Station; Dr. R. V. Allison, Bureau of Chemistry and Soils, U. S. Department of Agriculture; Dr. Oswald Schreiner, Division of Soil Fertility Investigations, U. S. Department of Agriculture; Dr. P. E. Brown, Iowa State College; Dr. S. Winogradsky, Pasteur Institute, France; Dr. A. A. J. De'Sigmond, Budapest, Hungary; Dr. Hendrik Lundegårdh, Experimentalfältet, Stockholm, Sweden, and Dr. W. P. Kelley, University of California.

To commemorate the eightieth birthday of Dr. Alfred Cort Haddon, fellow of Christ's College, Cambridge, and sometime university reader in ethnology, a number of friends under the guidance of Louis Clarke, curator of the Museum of Archeology and Ethnology, paid a tribute to the great services rendered by Dr. Haddon in the study of ethnology at a special gathering recently held in the museum at which a large cabinet to contain hundreds of indexed and catalogued photographs which Dr. Haddon had collected during the past forty years was presented to him. Professor Seligman, a former pupil and a colleague of Dr. Haddon in the Torres Straits Expedition, made the presentation, and in his reply Dr. Haddon announced his intention of handing over the photographs to the Board of Archeology and Ethnology of the university.

Dr. Herbert F. Prytherch, director of the U. S. Fisheries Biological Station at Beaufort, N. C., was recently elected president of the National Shellfisheries Association and chairman of the State Board of Directors of the North Carolina Fishermans Cooperative Association.

Officers of the British Institute of Physics have been elected as follows: *President,* Professor A. Fowler; *Vice-president,* Dr. G. W. C. Kaye; *Honorary Treasurer,* Major C. E. S. Phillips; *Honorary Secretary,* Professor J. A. Crowther; *New Members of the Board,* A. P. M. Fleming and Dr. B. L. Worsnop.

Dr. Charles Sidney Burwell, dean-elect and research professor of clinical medicine in the Harvard Medical School, formerly professor of medicine at Vanderbilt University, has been appointed to the staff of the Peter Bent Brigham Hospital, Boston, as physician, where he will continue clinical investigations of heart disease.

Dr. Roy R. Grinker, associate professor of neurology in the Graduate School of Medicine, Division of Biological Sciences of the University of Chicago, will be in charge of the new department of psychiatry, the establishment of which was recently made possible by a grant of $168,000 from the Rockefeller Foundation. Dr. Grinker will return to the university on July 1, after two years abroad spent in research under a fellowship from the foundation.

Dr. Nicholson J. Eastman, acting professor of

gynecology and obstetrics at Peiping Union Medical College, China, has been appointed professor of obstetrics at the Johns Hopkins Medical School and obstetrician-in-chief at the Johns Hopkins Hospital. Dr. Eastman will succeed Dr. J. Whitridge Williams, who died in 1931.

DR. R. E. COKER has been appointed chairman of the Division of the Natural Sciences in the senior college of the University of North Carolina. Under a new plan taking effect next session a senior college is formed with four divisions. The several divisions are concerned with programs of study, but not with administrative matters which remain in the hands of the deans.

COLONEL JAMES HIRAM GRAHAM, Louisville, consulting engineer, who graduated from the University of Kentucky in 1900, has been appointed dean of the College of Engineering.

PROFESSOR J. A. S. RITSON has been appointed to the chair of mining at the University of London, tenable at the Imperial College, Royal School of Mines, from January 1, 1936. Since 1923 he has been professor of mining at the University of Leeds.

THE court of the University of Glasgow has appointed Dr. T. Alty, research professor of physics in the University of Saskatchewan, to the Cargill chair of applied physics, vacant by the death of Professor J. G. Gray.

DR. J. A. MURRAY will retire as director of the British Imperial Cancer Research Fund at the end of the year. He will be succeeded by Dr. William E. Gye, of the National Institute for Medical Research, Hampstead.

THE trustees of the Louis D. Beaumont Trust have allotted $1,000 to the research department of the Barnard Free Skin and Cancer Hospital of St. Louis, Mo., of which Dr. M. G. Seelig is director. A similar allotment was made last year.

GRANTS awarded by the Committee on Scientific Research of the American Medical Association include a grant to Dr. Harold Jeghers for an investigation of vitamin A deficiencies in certain diseases—Dr. Jeghers will conduct his studies at the Boston City Hospital on the Fifth Medical Service under the auspices of the Department of Medicine of Boston University; to Dr. P. L. Heitmeyer, Portland, Ore., for research on intrauterine ovarian implants—his work on the problem was begun at the University of Pennsylvania Graduate School of Medicine and is to be continued at the University of Oregon Medical School; and to Dr. Avron Barnett, assistant in medicine at the Brooklyn Jewish Hospital, for researches concerning the mechanisms involved in impedance angle measurements. The work is to be carried out in the laboratory of pharmacology of Professor George B. Wallace, at the New York University College of Medicine.

DR. WINFRED OVERHOLSER, commissioner of mental diseases of Massachusetts, has appointed a "Departmental Research Committee" the purpose of which is stimulation and coordination of research activities in the State Hospitals of the Commonwealth. The members of the committee are Drs. Abraham Myerson, *chairman;* Douglas A. Thom, R. G. Hoskins, Neil A. Dayton and Harry D. Solomon. The Rockefeller Foundation is supporting research programs in the Worcester State Hospital and the Boston State Hospital as well as an elaborate statistical project of the department at Boston.

CARNEGIE CORPORATION grants to the value of £400 each for the year 1935–36 have been awarded by the executive council of the Universities Bureau of the British Empire to: Professor T. J. Haarhoff, of the University of the Witwatersrand; Professor T. H. Laby, of the University of Melbourne, and Professor Meghnad Saha, of Allahabad University.

DR. WILLIAM BEEBE and four associates, comprising the annual tropical research expedition of the New York Zoological Society, arrived at Hamilton, Bermuda, on June 2.

DR. JOHN FRANKLIN DANIEL, professor of zoology in the University of California, plans a nine-months' world tour of study and investigation during which he hopes to obtain more information on amphibian embryos.

DR. ROSS A. GORTNER, professor of agricultural chemistry at the University of Minnesota and chief of the division at the State Agricultural Experiment Station, will be the George F. Baker non-resident lecturer at Cornell University in the first term of the coming academic year. The general subject of the lectures will be "Colloids with Reference to Biochemical Problems."

THE graduation address at the Buckingham School, Cambridge, Mass., was given on June 7 by Dr. Harlow Shapley, director of the Harvard College Observatory.

DR. GANO DUNN, who is president of the board of trustees of Cooper Union, New York City, gave the commencement address at the union on June 6.

THE three hundredth anniversary of the National Museum of Natural History, Paris, will be celebrated from June 24 to 29.

IN Paris, from September 15 to 23, will take place the first International Congress for the Unity of Science, the general aim of which is to consider all ques-

tions relevant to scientific enterprise as a whole. A preliminary congress concerned with laying plans for the first International Congress was held in Prague, in September, 1934. The report of the preliminary congress is available in the journal *Erkenntnis*, or in book form from Felix Meiner (Leipzig). At that time a temporary committee of organization was formed with the following membership: Carnap (Prague), Frank (Prague), Jørgensen (Copenhagen), Lukasiewicz (Warsaw), Morris (Chicago), Neurath (The Hague), Reichenbach (Istanbul), Rougier (Cairo), Schlick (Vienna). A permanent committee is in process of formation, and acceptances to membership have been received from Bridgman, Cartan, Enriquez, Frèchet, Paul Gautier, Hadamard, Pierre Janet, Kotarbinski, Lashley, C. I. Lewis, C. Nicolle. When completed the committee will be representative of all the main fields of science. Correspondence may be addressed to the secretary, Dr. Otto Neurath, Mundaneum Institute, 267 Obrechtstraat, The Hague, Holland.

A MEETING and dinner of the Institute of Management, a research group of the American Management Association, was held in New York City on May 24. The morning session was devoted to a discussion of wage incentives methods. Dr. Richard Stephen Uhrbrock, head of the research department, Industrial Relations Division, the Procter and Gamble Company, presented the paper—"A Psychologist Looks at Wage Incentives Methods." Dr. Arthur W. Kornhauser, associate professor of business psychology, School of Business, University of Chicago, in collaboration with Paul Lazarsfeld, of the Psychological Institute, University of Vienna, gave the afternoon paper, which was on "The Techniques of Market Research from the Standpoint of a Psychologist." There was a dinner meeting in the evening, when the Henry Laurence Gantt Medal "for outstanding and creative work in the field of industrial relations" was presented to Arthur H. Young. Following the presentation Sumner H. Slichter, professor of business economics at the Graduate School of Business Administration of Harvard University, gave an address on "Current Labor Trends."

THE trustees of the Rockefeller Foundation have appropriated £60,000 towards the cost of the building and equipment of the proposed Institute for the Teaching and Study of Neurology at the National Hospital for Nervous Diseases, London, and a further sum of £60,000 towards the endowment for teaching and research which will have their center in the new building.

THE Regius professor of medicine at the University of Oxford, Sir E. Farquhar Buzzard, has introduced a statute to create an Institute for Medical Research. He pointed out that this was the latest development of a five years' scheme which had its origin in the purchase by Lord Nuffield from the Radcliffe Trustees of the observatory ground and buildings for the joint benefit of the Radcliffe Infirmary and the Oxford Medical School. The share of the university consisted of the buildings and a small part of the land. The institute will be partly devoted to therapeutic research and partly to x-ray cinematography. It will enable bachelors to do in Oxford the necessary work for the doctor's degree and may lay the foundation for a complete Medical School. It is hoped to establish the institute this year with Professor Gunn as its director and Dr. Franklin in charge of the x-ray cinematography.

THE new buildings of the British Postgraduate School at Hammersmith, associated with the University of London, were opened by the King and the Queen of England on May 13. The school is designed to provide post-graduate medical education for British doctors and for medical men from the Continent and abroad. The dean of the school, Colonel Alfred H. Procter, explained in a statement that for a long while there had been a great need in England for a center where post-graduates might revise and improve their medical knowledge. The school would also be a center where medical men from the Colonies could learn what was being done in London. It was decided in 1921 that a school should be established for qualified doctors and that the best solution to the problem was a separate hospital. A capital grant of £250,000 was proposed, but the financial crisis of 1931 made revision essential and eventually the government decided to make a grant of £100,000. The London County Council agreed to spend an equal amount. The new buildings—three blocks—were completed in January. Already post-graduate students from England, the Colonies and abroad are studying there, and four two-week refresher courses are beginning this month. A staff of professors and readers are at work.

Nature reports that the German government has issued an announcement referring to the work of the German bird migration research stations in Helgoland and at Rossitten where rings are attached every year to the feet of more than 160,000 migratory birds. The rings are inscribed with identification numbers and with the address of one or other of the stations. The stations are anxious to receive reports of the finding of these birds in any part of the world with the view of gaining further information as to bird migration and other phenomena of bird life. They will gratefully acknowledge all such reports, and are prepared to furnish in reply information not only as regards the bird in question, but also as regards their work generally. Reports will be sufficiently addressed if directed to Vogelwarte Helgoland, Germany, or Vogelwarte Rossitten, Germany.

DISCUSSION

JUVENILE CHARACTERS OF ROYAL PALMS

FOUR species of royal palms are now represented in southern Florida and may be distinguished in their juvenile stages by leaf characters that are not apparent in the adult palms. Flowers and fruits are not produced until the palms are from 25 to 30 feet tall, when the leaves and inflorescences are out of reach for comparison. Little dependence can be placed upon the sizes and shapes of the trunks, which vary with conditions of growth from slender and tapering to robust and ventricose. Most of the adult palms in Florida are of the native species, *Roystonea floridana*, which is being used extensively for street and ornamental planting, but other species are being introduced, so that means of distinguishing them are of increasing interest.

The Barbadian royal palm, *Roystonea oleracea*, is characterized by the pinnae of the juvenile leaves being wide and pendent, in contrast with narrow spreading or erect pinnae in the other species at the corresponding stages of growth, when the plants are from 3 to 6 feet high. In the younger stages of *oleracea*, the leaf-sheath, petiole and rachis are tinged with a deep red, the color being nearly the same as that of the small appressed scales scattered over the surface, while in the other species the surfaces are green, though the scales are reddish or brownish.

The leaves of the Cuban royal palm, *Roystonea regia*, have close-set narrow erect pinnae, in contrast with spreading or horizontal pinnae in other species at the same stage of growth. Also the reddish-brown scales of the leaf-sheaths continue in the Cuban species to be very abundant after the trunk-forming stage of the plant has been reached, and on many individuals even to the fruiting stage, while the other species have fewer and smaller scales, so that the leaf-sheaths usually appear entirely clean by the time that the trunks are a few feet high.

The royal palm of Puerto Rico, *Roystonea borinquena*, and the native royal palm of Florida, *Roystonea floridana*, are alike in the narrow spreading pinnae of their juvenile leaves, but the Puerto Rican species has a lighter green color and the surface scales reach a larger size, so that the rachis and petiole have a notably freckled appearance; also the midrib of the pinna has a readily perceptible row of scales, while in the Florida species the scales are relatively minute and inconspicuous, the difference being obvious when the pinnae are about half an inch wide.

The pinnae of *Roystonea floridana* later are much wider and rather close-set and drooping, in notable contrast with narrower and more erect pinnae in *Roystonea regia*, the Cuban species. Even in the adult stage a greater tendency to erect pinnae may be seen in the Cuban palm, though all the species share the adult character of having the pinnae inserted at different angles to the rachis. Another adult difference is that the petioles of the Florida palms tend to be more rigid, so that the leaves do not droop around the leaf-sheath bundle as in the Cuban species, but form a broad umbrella crown, in this respect having a greater resemblance to the Barbadian species, *Roystonea oleracea*.

O. F. COOK

BUREAU OF PLANT INDUSTRY

SYNCHRONOUS FIREFLY FLASHING

IN his recent note on synchronous flashing of fireflies experimentally produced,[1] Mr. John Bonner Buck regards his experiments with *Photinus pyralis* as indicating that "the whole process depends on the fact that all the [sedentary] females reply to each of the flashes of the male at the same definite [time] interval," thus gradually causing all the males approaching them on the wing to flash in unison. From the wording of the last two paragraphs of his note I infer that Mr. Buck interprets his observations on this one insect as offering a possible solution to the problem of synchronous flashing of fireflies in general. A tropical species of *Photinus*, however, a medium-sized, dark-colored Jamaican insect identified by Mr. H. S. Barber as probably *P. maritimus* E. Olivier, behaves so differently from *P. pyralis* as to convince me that there must be several causes of synchronous flashing and that the habit therefore needs to be separately studied and explained in each species that exhibits it.

On a broad open "common" near Mandeville, Jamaica, I found *Photinus maritimus* abundant during the latter part of February and the early part of March, 1931. I was told that simultaneous flashing was not unusual, but until March 8 I failed to see it. On that date, between 10 and 10:30 P. M., and on subsequent nights, I saw constellation-like groups of simultaneously flashing insects forming and disintegrating at different points among the large and active firefly population then on the wing. Sometimes it was possible to see as many as three such groups, each flashing like a constellation of from 20 to 40 stars. The flashes were single, of short duration, their apparent brightness at distances of from 50 to 75 yards intermediate between the luminosity of the north star

[1] SCIENCE, 81: 339–340, April 5, 1935.

and the brighter "pointers" of the dipper. The groups did not flash simultaneously with each other, but their rate, like that of the independent individuals, was very uniform—20 or 21 flashes to the minute. The groups would remain clearly defined for two or three minutes, each one drifting slowly and horizontally in its own direction at a height varying from 10 to 25 feet above the ground. They would then disintegrate, their members gradually "falling out of step" with each other. Not all the fireflies of this species in sight flashed with the groups—some were always showing their lights independently—but the great majority of those in a given area would temporarily band together.

At Pepper, in the Santa Cruz Valley, St. Elizabeth, on the evening of March 21, 1931, I saw two individuals, apparently of this same species, flying straight ahead across a common at a distance of about 20 feet from each other and 6 feet above the ground. While I watched them they flashed in perfect unison 14 times at intervals of about 3 seconds. They then disappeared behind some shrubbery. I did not measure the distance traversed in this way, but according to my recollection it could not have been much less than 100 yards.

Though I have no suggestion to offer regarding the cause of either of these types of simultaneous flashing I can not believe that they are to be explained as responses to females in the grass. Superficially, at least, they present an analogy with the simultaneous movements of birds in a flock or of fishes in a school.

GERRIT S. MILLER, JR.

U. S. NATIONAL MUSEUM

SCIENTIFIC MEN AND THE NEWSPAPERS

MORE important than any of the achievements of science are the philosophical implications of its discoveries—the need for leadership in thinking, leadership in the social and economic applications of the discoveries. In this leadership scientists are not prominent. Their failure to guide the public in adjusting the problems of plenty which the scientists have created may account largely for our economic and social crisis. This failure is due largely to the fact that the scientists have been keeping out of the newspapers, out of the place where the public can get acquainted with them, out of the place where the masses make up their minds what kind of leadership to follow.

The failure is mostly due to a mechanical maladjustment, to the fact that the scientists do not speak the language of the newspapers, that is, of the national forum. That language requires emotional appeal. For we are interested mostly only in those things which stir our emotions. We are likely to act only when our emotions are aroused.

The leaders of national thought take this emotional factor into account. If scientists did likewise, the public would listen to their message. It is because they have not done so that we see such an amazing situation as the attempts to solve unemployment without applying the first principle of science, which is to measure the precise dimensions of a problem. Because this principle is not understood, no one has taken an exact census of the unemployed.

The same lack is apparent in proposals to establish social security, such as old age pensions and unemployment insurance. The lack rises from the fact that the people as a whole have no adequate realization of the nature of the scientific approach.

They lack this realization because the scientists have not been telling in the newspapers the story of the frequently dramatic results of using the seemingly prosaic scientific approach. Much can be said on both sides as to why the scientists have kept out of newspapers. But I do not think there is any question about the harm done by the long years of scientific aloofness.

Honesty is the great need in guiding a baffled nation. I know of no place where all the principles of honesty, intellectual and moral, are so rigidly and openly spread as in the publications which scientists write for each other. These models the public almost never sees. The scientific riddles which are solved through this kind of honesty the public hears of only infrequently. Unless the public is to remain ignorant, and do so to its great harm, the place to tell about these scientific achievements and their implications is in the daily newspapers.

HOWARD W. BLAKESLEE,
Science Editor

THE ASSOCIATED PRESS
NEW YORK

BIOLOGICAL ABSTRACTS

WE believe that there are many zoologists who, like the writer, unconnected with *Biological Abstracts*, have heard with dismay of the reported decision of the Rockefeller Foundation to discontinue its support of that journal. Through a period of more than eight years we have become accustomed not only to lean heavily upon the *Abstracts* for information in our own fields of research, but also to use it for the revision and strengthening of our lecture notes in fields more remote. In the preparation of the latter we have become acquainted with many books and articles of which we would otherwise have remained totally ignorant. The titles of many biological publications are woefully inadequate in giving a true idea of their contents, and he who depends upon titles misses many sources of pertinent knowledge. The reading of the

best abstract, to be sure, falls short of the gain acquired by reading the article or book abstracted, but an abstract is better than complete ignorance of the publication concerned. Time in which to read all the originals is lacking with most teachers, who strive also to investigate. The cessation of the *Abstracts* would, therefore, mean loss to institutions and to their staffs in the value of both instruction given and research accomplished. We believe that the use of the *Abstracts* has brought home to us a realization that each volume, with all the advantages just hinted at, is really of much greater value to each of us, as individual teachers and investigators, than the nine dollars we have been paying for it each year. From the combined teacher-investigator standpoint, we, therefore, should look on the abandonment of the *Abstracts* as a distinctly backward step in biology. The wider view and the coordination of the various fields of biology which the *Abstracts* has made possible are indispensable. We trust that every effort will be made to secure adequate support for its continuance. We suggest that those who share our thoughts will, each, as far as his individual means allow, establish his own higher rate of subscription, thus showing, at the same time, his appreciation of the benefits which the *Abstracts* confers upon him. The *Abstracts* exists primarily for biologists, and it is the biologists who must largely determine whether it is to be continued or not.

PHILIP P. CALVERT
UNIVERSITY OF PENNSYLVANIA

REPORTS

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT its May, 1935, meeting, the Committee on Grants-in-Aid of the National Research Council made seventy awards as follows:

Physical Sciences: Sebastian Albrecht, research associate, Dudley Observatory, "stellar wave-lengths and standard radial velocities"; J. A. Bearden, associate professor of physics, Johns Hopkins University, "a repetition of the Millikan oil-drop experiment and a redetermination of the electronic charge"; Lee A. Dubridge, professor of physics, University of Rochester, "the photoelectric effect in the extreme ultra-violet"; Joseph Kaplan, assistant professor of physics, University of California at Los Angeles, "interpretation of the Aurora spectrum"; Gleason W. Kenrick, visiting professor of physics, University of Puerto Rico, "radio transmission with particular reference to phenomena peculiar to tropical latitudes"; M. Stanley Livingston, instructor in physics, Cornell University, "nuclear investigations"; J. Rud Nielsen, professor of theoretical physics, University of Oklahoma, "Raman spectra of simple polyatomic molecules"; T. Smith Taylor, professor of physics, Washington and Jefferson College, "development of a standard method for the measurement of the power factor of insulating materials over a frequency range of one megacycle to one hundred megacycles"; Samuel R. Williams, professor of physics, Amherst College, "inter-relations of magnetism and mechanical hardness"; Richard S. Zug, assistant professor of mathematics and astronomy, Drake University, "galactic star clusters."

Chemistry: Richard McL. Badger, assistant professor of chemistry, California Institute of Technology, "the spectra of the simpler polyatomic molecules in the photographic infrared"; James A. Beattie, associate professor of physico-chemical research, Massachusetts Institute of Technology, "relation of the International Temperature Scale to the absolute scale in the range from the freezing point of water to the boiling point of sulphur"; A. Witt Hutchison, assistant professor of chemistry, Pennsylvania State College, "measurement of heat capacities at temperatures attainable with liquid helium"; H. I. Schlesinger, professor of chemistry, and W. C. Johnson, associate professor of chemistry, University of Chicago, jointly, "the hydrogen compounds of boron, silicon and arsenic, and their derivatives"; Nelson W. Taylor, professor of ceramics, Pennsylvania State College, "activation energies in solid phase reactions involving the various polymorphic forms of silica"; Arthur A. Vernon, instructor in physical chemistry, Rhode Island State College, "solubility of electrolytes in non-aqueous solvents"; Roger J. Williams, professor of chemistry, Oregon State College, "the chemical isolation and study of pantothenic acid."

Geology and Geography: Charles Deiss, associate professor of geology, University of Montana, "stratigraphic and paleontologic studies of the Cambrian formations of Montana and Wyoming"; Donald McCoy Fraser, assistant professor of geology, Lehigh University, "petrogenesis of the crystalline rocks in eastern Pennsylvania"; Elbridge C. Jacobs, professor of geology, University of Vermont, "installation of a seismograph for the completion of the seismographic station at the University of Vermont"; K. C. McMurry, professor of geography, University of Michigan, "development of methods for utilizing aerial photography in land inventory and classification"; Oscar B. Muench, professor of chemistry and physics, New Mexico Normal University, "determination of the age of samples of monazite and thucholite from Glorieta, New Mexico"; F. J. Pettijohn, assistant pro-

fessor of geology, University of Chicago, "analysis and correlation of areal mapping in the Lake Superior pre-Cambrian province"; Gordon Rittenhouse, research assistant in geology, University of Minnesota, "geology of a portion of the Savant Lake area in northwestern Ontario"; Harold W. Scott, instructor in geology, Montana School of Mines, "the micro fauna of the Carboniferous of Montana"; W. H. Twenhofel, professor of geology, and R. R. Shrock, assistant professor of geology, University of Wisconsin, jointly, "field and laboratory studies of the Silurian of Newfoundland."

Medical Sciences: M. Bodansky, professor of pathological chemistry, University of Texas Medical School, "the relation of the thyroid and adrenals to the composition and metabolism of cardiac and skeletal muscle"; S. J. Crowe, adjunct professor of laryngology and otology, Johns Hopkins University School of Medicine, "the rôle of the several parts of the middle and inner ear in hearing"; George M. Curtis, professor of surgical research, Ohio State University Medical School, "daily loss of iodine due to toxic goiter"; Harry H. Donnally, professor of pediatrics, George Washington University School of Medicine, "the use of culture-grown vaccinia virus in vaccinating newly born infants"; J. A. E. Eyster, professor of physiology, University of Wisconsin, "action potentials in heart and skeletal muscle"; Louis F. Fieser, associate professor of chemistry, Harvard University, "carcinogenic hydrocarbons and their derivatives"; E. M. K. Geiling, associate professor of pharmacology and experimental therapeutics, Johns Hopkins University Medical School, "histological and pharmacological study of the glands and other parts of whales"; Edward L. Howes, research assistant in surgery, Yale University School of Medicine, "wound healing strength"; William G. Lennox, instructor in neurology, Harvard University Medical School, "the electrical activity of the brain as related to clinical neurology"; Valy Menkin, instructor in pathology, Harvard University Medical School, "tuberculosis and inflammation in relation to bacterial invasiveness"; C. Phillip Miller, associate professor of medicine, University of Chicago Medical School, "the immunological properties and toxicity of various chemically isolated fractions of the meningococcus cell"; Mont R. Reid, professor of surgery, University of Cincinnati College of Medicine, "therapeutics of arterial disease"; B. T. Simms and J. N. Shaw, professors of veterinary medicine, Oregon State College, jointly, "lungworm infestation in sheep and goats"; Robb S. Spray, professor of bacteriology and public hygiene, West Virginia University Medical School, "taxonomic study of the sporulating anaerobes"; Charles W. Turner, associate professor of dairy husbandry, University of Missouri, "the physiology of the hypophysis in relation to lactation"; William F. Windle, associate professor of anatomy, Northwestern University Medical School, "development of behavior in the embryo correlated with development of intrinsic structure of the nervous system"; J. M. Wolfe, assistant professor of anatomy, Vanderbilt University School of Medicine, "morphologic studies on the relation of the anterior pituitary to the reproductive system"; Isolde T. Zeckwer, associate in pathology, University of Pennsylvania School of Medicine, "morphological and functional studies of the pituitaries of rats following thyroidectomy."

Biological Sciences: S. Prentiss Baldwin, director of the Baldwin Bird Research Laboratory, Cleveland, "metabolism of bird embryos during incubation"; Sherman C. Bishop, professor of zoology, University of Rochester, "the salamanders of North America north of Mexico"; H. O. Burdick, associate professor of biology, Alfred College, "the physiology of fallopian tubes and factors controlling the passage of ova through these tracts"; Charles E. Burt, professor of biology, Southwestern College, "phylogenetic study of the North American lizards"; J. F. Gates Clarke, instructor in zoology, State College of Washington, "revision of the North American moths of the Genera *Agonopteryx* and *Depressaria*"; Harry F. Clements, associate professor of botany, State College of Washington, "the freezing resistance in the needles of *Pinus ponderosa* and *Pseudotsuga taxifolia*"; Elizabeth Fekete and C. V. Green, research associates, Roscoe B. Jackson Memorial Laboratory, jointly, "the effect of the removal of the mammary glands on the incidence of tumors in a 'high tumor' strain of mice"; William R. Horsfall, professor of biology, Agricultural and Mechanical College, Arkansas, "the abundance and distribution of species of mosquitoes in southeastern Arkansas"; R. R. Huestis, professor of zoology, University of Oregon, "the inheritance of brown, silver, and flexed tail in *Peromyscus maniculatus*"; F. B. Hutt, professor of poultry husbandry and animal genetics, Cornell University, "the pathological chemical embryology associated with the occurrence of chondrodystrophy in embryos of the domesticated fowl"; Alfred C. Kinsey, professor of zoology, Indiana University, "collection and study of Mexican gall wasps and their oak hosts"; Leon H. Leonian, mycologist, West Virginia Experiment Station, "the isolation and identification of growth and sexuality promoting substances for fungi"; C. C. Little, director of the Roscoe B. Jackson Memorial Laboratory, "the transplantation of early unimplanted ova from the fallopian tube of pregnant mice of a high tumor stock to the uterus of pregnant animals from a low tumor stock, and *vice versa*"; A. B. Stout, director of the laboratories, New York Botanical Garden, "seedless-

ness in grapes"; Don C. Warren, professor of poultry genetics, Kansas State College, "the phenomenon of ovulation in the domestic hen"; Allyn J. Waterman, assistant professor of biology, Williams College, "heteroplastic transplantations of rabbit and rat embryos"; P. W. Whiting, guest lecturer in zoology, University of Pennsylvania, "sex-determination in the parasitic wasp Habrobracon."

Anthropology and Psychology: Fay-Cooper Cole, professor of anthropology, University of Chicago, "racial criteria in the study of hair"; Ernest R. Hilgard, assistant professor of psychology, Stanford University, "quantitative characteristics of the process of acquisition and extinction of conditioned responses in man"; William A. Hunt, assistant professor of psychology, Connecticut College, "behavioral response to a shot stimulus"; Theodore F. Karwoski, assistant professor of psychology, Dartmouth College, and Mason Crook, instructor in psychology, University of California at Los Angeles, jointly, "quantitative investigation of the sensitivity of the blind spot for spectral light"; Paul Kirchhoff, research associate in anthropology, Columbia University, "native agriculture in South America"; Karl F. Muenzinger, associate professor of psychology, University of Colorado, "analysis of the function of punishment in learning"; Sidney M. Newhall, Sterling fellow, Yale University, "imagery in recurrent vision"; Cornelius Osgood, assistant professor and curator of anthropology, Yale University, "study of the existing anthropological collections from the Athapaskan Indians of Canada and Alaska which have been deposited in museums of northeastern Europe, especially Russia"; Vincenzo Petrullo, field director for South American research, University of Pennsylvania, "ethnological studies of the Yaruro peoples in Venezuela."

There will not be another meeting of the Committee on Grants-in-Aid this year. The next meeting of the committee will be held in March, 1936. Applications to be considered at this meeting must be on file with the Secretary of the Committee, Dr. Clarence J. West, not later than February 15, 1936.

ISAIAH BOWMAN,
Chairman, National Research Council

STATE ACADEMIES

THE OHIO ACADEMY OF SCIENCE

THE forty-fifth annual meeting of the Ohio Academy of Science was held on April 19 and 20, 1935, at the Ohio State University, under the presidency of Dr. James P. Porter, of Ohio University, Athens. The attendance was good, some 200 members and a large number of visitors, the sectional programs were rich and varied, and a fine spirit of good fellowship was evident on every hand. President Rightmire, of the Ohio State University, in his usual pleasing manner bade the academy welcome to the university and made some very fine remarks on the service of science to humanity. The invitation address was given by Mr. Julius F. Stone, traveler, lecturer, capitalist, on the subject, "The Canons of the Green and Colorado Rivers," illustrated with many beautiful slides. The president of the academy, Dr. Porter, chose for the subject of his presidential address, "Our Sciences with Man Left in," which he presented in a masterly way to the delight and enrichment of a large, select audience. Two other papers of general interest were presented before a general session of the academy, namely, one on "Some Scientific and Technical Problems Met with in Investigating the Explosion of the State Office Building," by Dr. James R. Withrow, of Ohio State University, and the other on "Bobwhite: Song Bird or Game Bird," by Dr. S. Prentiss Baldwin, of the Baldwin Research Laboratory, Gates Mills, Ohio.

Other outstanding features of the meeting were a joint meeting of the section of psychology and the Ohio Association of Consulting Psychologists, and a symposium on chemistry in biology under the joint auspices of the sections of botany and chemistry. All told, about 120 papers were presented in the various sectional meetings. The exhibits and demonstrations were of unusual interest, notably the *heavy water exhibit,* the spectrographic laboratories, ceramics and metallurgy, all of the department of chemistry of the university; also the earthworm (Nephridia in vitro) by Miss Hope Hibbard, of Oberlin College, and some smaller mammals of Wayne County, Ohio, by Earl Cady, of Wooster College.

Some 22 new members were elected, and the following members were advanced to the rank of fellows in the academy: Dr. Mary Auten, Ashland College; Dr. Earl Clark Case, University of Cincinnati; Dr. Fred Foreman, Oberlin College; Dr. Reuel B. Frost, Oberlin College; Dr. Amos Henry Hersh, Western Reserve University; Dr. Herrick Lee Johnston, Ohio State University; Dr. Samuel Charles Kendeigh, Baldwin Bird Research Laboratory, Gates Mills, Ohio; Dr. Harvey V. Moyer, Ohio State University; Dr. Ira Templin Wilson, Heidelberg College.

The academy passed the following resolutions regarding the so-called "Pest Hunts": "*Resolved,* That the Ohio Academy of Science urges the State Division of Conservation to initiate a thorough, scientific study of all predatory mammals in Ohio, to determine their distribution, abundance, rate of increase, and food

species eaten at various seasons and in various sections, and their economic relationships in the several parts of the state."

The forty-fifth meeting was brought to a close by the election of the following officers for the ensuing year:

President, Dr. Walter H. Bucher; *Vice Presidents—Zoology,* Dr. David F. Miller; *Botany,* Dr. Glenn W. Blaydes; *Geology,* Dr. Grace Ann Stewart; *Medical Sciences,* Dr. Charles A. Doan; *Psychology,* Dr. James R. Patrick; *Physics and Astronomy,* Dr. Charles W. Jarvis; *Geography,* Dr. Guy-Harold Smith; *Chemistry,* Dr. K. G. Busch; *Secretary,* William H. Alexander; *Treasurer,* Dr. A. E. Waller; *Members of the Executive Committee,* Dr. James P. Porter and Dr. Eugene Van Cleef.

William H. Alexander,
Secretary

THE IOWA ACADEMY OF SCIENCE

The forty-ninth annual meeting of the Iowa Academy of Science was held with Grinnell College at Grinnell on April 19 and 20 with 249 members and visitors in registered attendance.

The presidential address, "This Changing World," was presented by Professor Edward Bartow, of the department of chemistry of the State University of Iowa. Other papers of general interest were: "The Neural Basis for a Psychogenetic Theory of Feeling and Emotion," by Professor C. A. Ruckmick, of the department of psychology of the State University of Iowa, and "Some Factors Affecting the Circulation Time of the Blood of Dogs," by Professor E. C. McCracken, of the department of physics of Iowa State College. The annual academy lecture was presented by Dr. Leroy C. Stewart, of the Dow Chemical Company, of Midland, Michigan. His subject, "The Magic Key," described and illustrated the production of bromine from sea-water.

The following officers and section chairmen were elected for the forthcoming meeting, which is to be held at Iowa City in April, 1936: *President,* R. E. Buchanan, Iowa State College; *Vice-President,* L. P. Sherman, Grinnell College; *Secretary-Treasurer* and *Representative of the American Association for the Advancement of Science,* J. C. Gilman, Iowa State College; *Editor,* Mrs. F. W. Nichols, Ames, Iowa; *Bacteriology and Botany,* H. A. Wilson, Coe College; *Chemistry, general and physical,* William Oelke, Grinnell College; *Chemistry, organic and biological,* Rachel Edgar, Iowa State College; *Geology,* J. E. Smith, Iowa State College; *Psychology,* A. R. Lauer, Iowa State College; *Mathematics,* Julia Colpitts, Iowa State College; *Physics,* Gerald Fox, Iowa State College; *Zoology,* U. A. Hauber, St. Ambrose College.

The academy convened in eight sections for the presentation of 117 papers of special interest. The Junior Academy of Science of Iowa met with the academy with an attendance of 150 members aside from the Grinnell High School students. Dr. R. W. Getchell, of the Iowa State Teachers College, Dr. W. F. Loehwing, of the State University of Iowa, and Dr. E. W. Lindstrom, of the Iowa State College, presented talks on their program.

Joseph C. Gilman,
Secretary.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ILLUMINATOR FOR THE BINOCULAR DISSECTING MICROSCOPE

For viewing a transparent object by transmitted light with a binocular dissecting microscope, the ordinary artificial light sources do not easily provide equal illumination to both eyes. This difficulty has frequently been of considerable importance in the examination of nematode larvae in uncovered drops of water, but it has been obviated by the use of the illuminator described here. The basic principle of this device consists of the use of two equal light sources placed at such a distance apart that the same mirror reflects both beams squarely into the corresponding objectives. The particular design used has several additional advantages. The entire system is enclosed as a dust-tight unit to improve its efficiency and save cleaning time. In spite of the complete enclosure, the exposed surfaces are large enough to dissipate the heat rapidly and at a sufficient distance from the operator to eliminate any discomfort even in the hottest weather. The light sources and all reflecting surfaces are entirely removed from the field of vision, an important factor in the reduction of eye strain.

The entire unit is mounted in a sheet tin box, 25 by 40 cm and 19 cm high, with a tight-fitting slip-over cover. The box is painted dull black inside and out. In the accompanying figure the component parts are shown approximately to scale in positions for a microscope placed with the center of the mirror 10 cm from the window. Two sockets with an identical pair of ordinary 25 watt, inside-frosted bulbs are mounted in

[1] The studies and observations on which this paper is based were conducted under the auspices of the Department of Public Health of the Egyptian Government and the International Health Division of The Rockefeller Foundation.

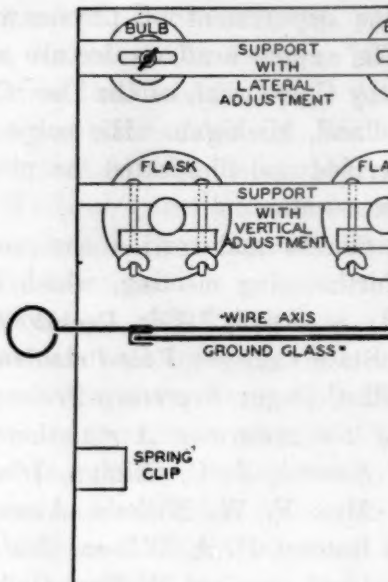

FIG. 1. Illuminator for viewing a transparent object by transmitted light with a binocular dissecting microscope.

inverted position on a wooden cross-piece in such a way as to provide for lateral adjustment. In front of the bulbs are two identical 500 cc flasks with alkaline copper sulfate solution. They are held in clamps to allow vertical adjustment and are at such a distance apart as to give a correct angle between the beams at the microscope mirror. In front of these flasks is a ground glass from a 5 by 7 inch camera. This glass is mounted in two pieces of folded tin soldered at the top to a heavy wire running through the two sides of the box and bent at one end to form a handle. By rotating this wire, the glass can be raised out of the beam of light into a horizontal position and held there by a spring clip. The window in front is 8 cm high and is made of a lantern slide cover or other piece of plane glass slid into a dust-tight groove.

In assembling the outfit care should be taken with regard to rotation of the bulbs so as to present the flat surface of the filament to the flasks. The distances between the bulbs and the flasks must be determined empirically according to the condensing focus of the particular flasks used. The other distances can be approximately determined from the distance at which the microscope is to be used, and by means of the clamps, final adjustment can be made to the position of greatest efficiency in actual use.

J. ALLEN SCOTT

PUBLIC HEALTH LABORATORIES
CAIRO, EGYPT

A MODIFIED BULB PIPETTE

WHILE isolating and transferring Protozoa with a pipette of the medicine dropper type, it occurred to the writer that the manipulation of the pipette might be made much easier if the rubber bulb were moved down over the pipette a short distance. This actually proved to be the case when pipettes of this type were made and used for various types of work. The writer has found no mention of such a modification in the literature and felt that a sketch and a few explanatory remarks as to the construction of the pipette might be of some value to others.

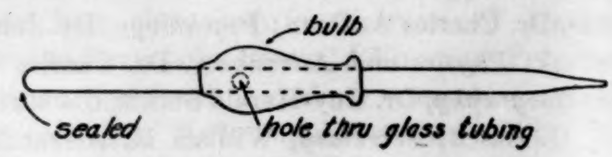

FIG. 1.

The pipette, shown in the accompanying figure, is not difficult to make. One end of a length of glass tubing is first sealed with a flame. The region where the bulb is to be placed is then heated with a small flame and a hole is blown through. The edges of the hole are then rounded down in the flame. A small hole is made in the end of an ordinary rubber pipette bulb, and the bulb is pushed down over the glass tubing. It is placed in such a position that the chamber of the bulb will communicate with the lumen of the pipette by means of the hole previously made in the side of the tubing. To insure a tight fit, cord or fine wire may be wrapped and drawn up over either end of the bulb. The open end of the glass tubing is then heated and drawn out.

The size and kind of glass tubing, as well as the length of the pipette, the size of the point, and the place for the bulb will depend upon the preference of the user and the use to which the pipette is to be put.

JOHN C. LOTZE

OHIO STATE UNIVERSITY

NEW TOWER FILLING MATERIAL

MANY types of tower packing are at present available for such purposes as filling reaction, absorption and distilling towers. The author has recently developed a novel form which is free draining and presents a large active surface per unit volume. It consists of a maltese cross whose wings have been rotated a sufficient number of degrees (for example, thirty degrees) to impart a rotating motion to the gas passing through the packing. This packing may also be made in circular form, with two or more wings, in which case it roughly resembles a propeller. Projections or webs may be added for structural strength or to prevent too close contact between adjacent packing units. For example, the center may be considerably thickened so that if two units superimpose they will not touch at all points. Holes may be introduced for drainage. Two or more units may be connected by webs or other

suitable means if so desired. The packing wings may be either plane or curved surfaces, or with suitable projections, and may be made of any of the usual materials of construction, such as stoneware, copper or wire screen.

A. McLAREN WHITE

CHAPEL HILL, N. C.

SPECIAL ARTICLES

POTENTIAL RHYTHMS OF THE CEREBRAL CORTEX DURING SLEEP

RECENT interest in brain potentials has induced us to put on record the results of experiments carried out in the Loomis Laboratory, Tuxedo Park, in which a new phenomenon in this fascinating field has appeared most clearly—namely, the very definite occurrence of trains of rhythmic potential changes as a result of sounds heard by a human subject during sleep. Since the work of previous investigators[1] has emphasized that rhythms which spontaneously appear in a person at rest with eyes closed disappear when an object is viewed or the attention concentrated, we believe the definite demonstration of a means of inducing rhythmic brain discharges to be of considerable interest. At the same time the method of continuous study and correlation with other body changes over periods of seven hours, described herein, greatly facilitates interpretation of results where many factors, difficult to control, are undoubtedly involved. Sleep was selected as a condition during which brain activity is at a minimum and physiological conditions most constant.

The records are made on paper wrapped on a horizontal drum 8 feet long and 44 inches in circumference revolving once a minute. Two high-speed dynamic siphon recorders describe a pair of spiral lines one fifth inch apart, as they move horizontally parallel to the drum at the rate of one foot per hour. Each heart beat, each respiration, each bed movement and any noises in the bedroom are recorded by one pen (red ink) as characteristic marks, while brain potentials are recorded by the other pen (green ink). In addition three rachet devices sum the heart beats, the respirations and the bed movements each minute, marking the rate per minute on the paper. The drum, driven by a synchronous motor, acts as its own clock, and stimuli may be sent to the sleeper each minute by electric contact on the drum, thereby placing a series of responses near together on the record and allowing easy comparison with the condition where no stimuli are sent in. The amplitude of the brain potentials are ascertained regularly by calibration with sinusoidal potentials of from 2 to 30 per second frequency and from 10 to 50 microvolts amplitude. The siphon recorder records have been checked from time to time by the cathode ray oscillograph.

The finished record is a sheet of paper 44 inches high and 8 feet long with vertical red and green lines, each pair representing a minute of time. Changes in the processes recorded can be seen at a glance. Either the red or the green lines can be rendered invisible by viewing the record through a red or green glass and inspection thereby simplified. The single sheet of paper, even though large, is a great improvement over the use of paper tape, which was abandoned because examination of the one half mile of tape necessary for an eight-hour run was too time-consuming.

The subject sleeps in a quiet, electrically screened room, containing a very sensitive microphone and a photo-electric bed movement recorder. Electrodes for detecting the various physiological processes are attached to the subject and the amplified impulses sent through shielded cables to the control room 66 feet away. Details of the apparatus will be described in a later paper. Facial movements, swallowing, clenching the jaws, etc., give rise to muscle potentials which appear on the record, but which are quite characteristic and easily distinguishable from brain potentials, as are also disturbances due to passive movements of the scalp.

Our investigation of the brain potential rhythms during night sleep (brain electrodes on high forehead and crown of head) has led us to the following conclusions:

(1) They are undoubtedly of cortical origin and distinct from muscle potentials and movement artifacts. Different persons show quite different potential records.

(2) In a night record certain hours of sleep show many "spontaneous" bursts of waves, while other hours show relatively few.

(3) They often appear in trains lasting 5 to 12 seconds, at intervals of ½ to 2 minutes.

(4) The frequency is on the average an irregular 10 per second, but frequently very regular bursts lasting 1 to 1½ seconds of 14 per second frequency appear. The amplitude builds regularly to a maximum and then falls regularly so that we have designated these "spindles," because of their appearance in the record. Shorter spindles or "balls" of ¼–⅓ second duration occasionally appear. Five other types can also be distinguished.

(5) They are not correlated with heart beat nor necessarily with respiration, but at times a definite characteristic potential change has accompanied each respiration.

(6) Regular snoring does not necessarily initiate

[1] Literature in paper by Adrian and Mathews, *Brain*, 37: 355, 1934; also Jasper and Carmichael, SCIENCE, 81: 51, 1935. See H. Berger in *Arch. f. Psychiat.*, 1929–35.

brain rhythms, but an occasional isolated snore may start a train.

(7) When asleep sounds of a certain character, such as rustling paper or coughing by a person in the bedroom, closing a door some distance from the subject or low conversation, which does not wake the sleeper, will quite regularly initiate a train of waves which may last for from 5 to 8 seconds (frequency 9 to 10/seconds) and then die out. Fig. 1 A illustrates this effect from the repeated closing of a door at one-minute intervals and allows comparison with regions where no sound stimuli were sent in. The depth of sleep and the noise level in the room determine whether this "sound response" will appear. One deep sleeper gave no response on closing the door but responded regularly on slamming the door.

(8) When awake, the same sounds that during sleep initiate a train of waves no longer give rise to them. Fig. 1 B clearly shows this.

(9) During sleep trains of waves appear which can not be correlated with any detectable external stimulus, but which may be connected with internal disturbances of unknown origin. The cause of these very regular bursts is now under investigation.

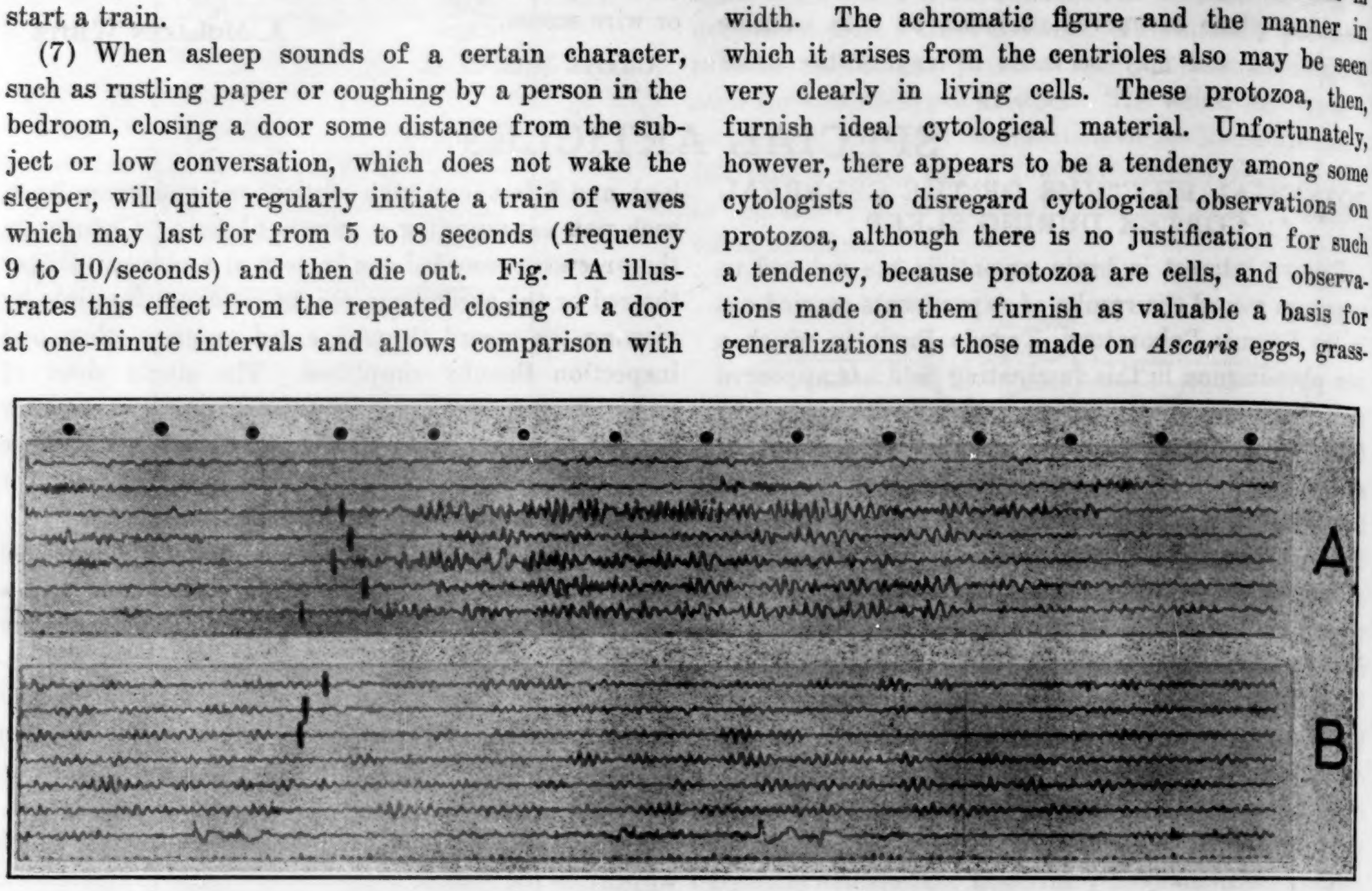

FIG. 1. Sections of brain potential records each taken one minute apart. Read from left to right. At vertical mark sound stimuli sent to subject. Note marked trains of brain rhythms in A when subject asleep but none in B when subject awake, although stimulated by same sound. Time in seconds given by dots at top.

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THE CENTRIOLE AND ITS ROLE IN MITOSIS AS SEEN IN LIVING CELLS

THE centrioles in the various genera and families of hypermastigote flagellates[1] range in length from 2 or 3 microns to 80 or more and may be seen easily in living organisms, since they are 1 to 3 microns in width. The achromatic figure and the manner in which it arises from the centrioles also may be seen very clearly in living cells. These protozoa, then, furnish ideal cytological material. Unfortunately, however, there appears to be a tendency among some cytologists to disregard cytological observations on protozoa, although there is no justification for such a tendency, because protozoa are cells, and observations made on them furnish as valuable a basis for generalizations as those made on *Ascaris* eggs, grasshopper testes or other types of classical material. Indeed, most of the Hypermastigina show much more clearly than any other known cells the centrioles, the manner of their duplication, the formation of the achromatic figure from them and the rôle of the achromatic figure in chromosome movement. Furthermore, observations on living material of these organisms show beyond question that the observations on fixed and stained material deal with realities, not artifacts produced by fixation. And the close similarity between the behavior of these hypermastigote centrioles and the centrioles of other cells leaves no room to doubt the general application of the observations on these flagellates to mitosis in both animals and plants.

In some genera, particularly those with short centrioles as in *Joenia, Mesojoenia* and other genera of the Lophomonadidae, the achromatic figure arises from the greater portion of the centriole; in other genera, with longer centrioles, it arises only from the distal half or third of the centriole; and in those genera with elongate centrioles, it arises from only a small portion of the centriole, the distal portion. In certain genera, the distal portion of the centriole from which the achromatic figure arises is surrounded by a

[1] The names of the 29 genera and 6 families need not be given here, since they are given in a recent publication to which the reader interested in them is referred (*Mem. Amer. Acad. Arts and Sciences*, Vol. 17, No. 2, 1934).

hyaline centrosome which (in different genera) varies from 2 to 6 microns in diameter; while in other genera no portion of the centriole is surrounded by a centrosome. The fibers of the achromatic figure arise from the centriole, not from the centrosome. The latter, when present, merely serves a minor function in directing the fibers so as to make the central spindle portion of the achromatic figure less flat or band-like. This may be seen by comparing the central spindle of *Barbulanympha* with that of *Staurojoenina*.

In the interphase in some genera the two centrioles are of equal length, either short or long; while in other genera there is one short and one elongate centriole, the short or daughter centriole elongating in the early prophase. In other genera, both centrioles are short in the interphase and elongate in the early prophase. After these centrioles have functioned in the production of the achromatic figure, cytoplasmic division occurs and each daughter cell receives one elongate centriole, which soon degenerates except for the proximal portion, so that in the interphase the parent as well as the daughter centriole is short. In brief, then, there are (1) short interphase centrioles which function without elongation; (2) short interphase centrioles which elongate in the early prophase; (3) one long and one short centriole in the interphase, the short one elongating in the early prophase; and (4) two elongate centrioles in the interphase. The centrioles are continuous from one cell generation to the next, a new one being produced from the proximal portion of an old or persisting centriole during each cell division.

In addition to the achromatic figure, all the other extranuclear organelles, such as flagella, parabasals, axostyles, etc., arise from the centrioles, so that the centriole is clearly an autonomous organelle, and the dynamic center of the cell since it reproduces itself and all the other organelles except the nucleus. (It should be noted, however, that, except in a few genera during the annual encystation generation, the production of flagella and other extranuclear organelles from the centrioles occurs one generation before the production of the achromatic figure. See footnote 1.)

The achromatic figure which arises from the centrioles is composed of astral rays, some of which join and overlap to form the central spindle, some of which become extranuclear chromosomal fibers, and some of which remain as astral rays throughout mitosis and hence perform no apparent function. It is perhaps desirable, however, to avoid the use of the long-used term spindle, since it has been used to refer to either the central spindle or the extranuclear chromosomal fibers or both. At least, there is less likelihood of confusion if the three parts of the achromatic figure are referred to as astral rays, extranuclear chromosomal fibers and central spindle. Of course, it must be realized that the fibers of the central spindle and the extranuclear chromosomal fibers are merely astral rays that are functioning in the process of nuclear division, those of the central spindle serving as a stabilizer which prevents the nucleus from being pulled in two before the proper movement and distribution of the chromosomes, and those that are attached to the chromosomes serving to move the chromosomes to the poles.

The formation of the achromatic figure is initiated by the outgrowth of astral rays from each of the interphase centrioles which, in different genera, lie from 5 to 40 microns apart in the cytoplasm. The distance from nucleus to centrioles varies in different genera from 2 to 3 microns to 50 or more. As the astral rays elongate, those arising from one centriole soon meet those arising from the other centriole; when they meet, they join, grow along one another and overlap, thus forming the central spindle, which as it develops depresses the ever intact nuclear membrane and takes up an axial position. In the meantime, chromosomes have formed and each chromosome is anchored to the nuclear membrane by an intranuclear chromosomal fiber which varies considerably in length in different genera and which should probably be considered a part of the chromosome. In most genera there is an enlargement or knob where each intranuclear chromosomal fiber joins the nuclear membrane. Presently some of the astral rays become extranuclear chromosomal fibers by connecting with the knobs or "kinetic bodies" of the intranuclear chromosomal fibers in the nuclear membrane. When such a connection is established, the chromosome is connected with the centriole. Not all the connections are made at the same time, but eventually all the chromosomes are connected with the centrioles in this manner, half being connected with one centriole and half with the other, so that as the centrioles of the dividing cell separate the daughter chromosomes are moved to the poles. The fibers composing the central spindle pull apart, and presently the achromatic figure begins to disappear, the last part to disappear being the extranuclear chromosomal fibers. No other fibers are present during mitosis, and it appears to the writer that the so-called interzonal fibers, sometimes described during mitosis, particularly in the anaphase, are either the fibers of the central spindle or connections between the two groups of daughter chromosomes which, in certain forms, pull out for a considerable distance before pulling in two.

In the interphase the centrioles (and the centrosomes too in those genera where they are present) may be moved for a considerable distance by mechanical means without altering their appearance in the least. In fact, it is only when the cell is completely

destroyed that they disappear. And when the achromatic figure has been formed from the centrioles, it is possible not only to see that the daughter chromosomes are connected to the centrioles, but also to demonstrate such a connection by pulling either of the centrioles away from the nucleus, the chromosomes moving with the centriole as it is pulled. Such a procedure also demonstrates the elasticity of the extranuclear chromosomal fibers and those of the central spindle, for unless the centriole is pulled a considerable distance (far enough to break the fibers) from the nucleus, it and the chromosomes pulled with it immediately spring back into position when the tension is released. Thus, in these organisms, there is not the slightest doubt regarding the existence of the centrioles, the formation of the achromatic figure from the centrioles, the fibrillar nature of the achromatic figure, and the rôle of the achromatic figure in nuclear division.

The question naturally arises: Are all centrioles like those of hypermastigote flagellates and do they function in the same manner? As already noted hypermastigote centrioles vary considerably in size and in the type of achromatic figure that arises from them. In some genera the central spindle is flat and band-like, in some it is cylindrical, in some it is compact, and in some it is dispersed. In certain genera the astral rays are fine and can not be seen so readily as in others, and in those with fine astral rays the extranuclear chromosomal fibers are more difficult to see. In brief, there is every gradation beginning with genera having large centrioles and a large achromatic figure which may be seen with a 16 mm objective and a 10X ocular, and ending with those where the centrioles and achromatic figure may be seen only faintly with oil immersion objectives. So that it is only a short step from hypermastigotes of the last category to the cells of other forms of life where, in fixed and stained material, the centrioles and the achromatic figure have the same appearance as those of hypermastigotes in living material. In this connection it should be noted that in the polymastigotes *Saccinobaculus* and *Pyrsonympha* the intranuclear achromatic figure may be seen in living cells, but the centrioles from which it arises can not be seen, and in fixed and stained material the centrioles can be seen in only one of the three species of *Saccinobaculus*. There are evidently all gradations of centrioles, from the large, dense ones of certain hypermastigotes to the less dense and diffuse ones of other cells, and whether a centriole can be seen in living or in fixed and stained material depends on its nature and that of the cytoplasm or nucleoplasm in which it lies. The same is also true of the achromatic figure. But the ability to demonstrate a centriole only under certain conditions of fixation and staining does not indicate that it is an artifact; nor does the inability to demonstrate it at all indicate that it is not present. It merely means that its nature is such that it can only be seen under certain conditions or that it can not be seen at all with the aid of any known technique. In any cell —and this includes practically all cells—where some type of an achromatic figure is formed, centriolic material must be present; it may be congregated into a large, dense, extranuclear body as in some hypermastigotes or, on the other hand, it may be rather generally scattered through the nucleus as in the cells of many vascular plants. There is no reason why the centriole and the achromatic figure should be less variable in different types of cells than other organelles. And the fact that the centriole in certain animal and plant cells give rise to flagella, as well as to the achromatic figure, does not appear to be sufficient reason for regarding it as another organelle, since in some generations (cell divisions), both in animals and plants, the centriole gives rise only to the achromatic figure, while in other generations it gives rise to flagella and the achromatic figure. In such organisms, then, which are by no means few in number, the same body sometimes would be considered a centriole and at other times something else. What appears to be the best explanation of the situation is that in certain forms the centriole still possesses the ability to give rise to locomotor organelles in addition to the achromatic figure, while in other forms either it has never performed this dual function or this ability has been lost, or there is no longer any need for the centriole to produce locomotor organelles. If there are cells where the locomotor organelles arise from a body that does not produce the achromatic figure, the term blepharoplast appears applicable to this body.

L. R. CLEVELAND

HARVARD UNIVERSITY MEDICAL SCHOOL

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AITKEN, ROBERT G. *The Binary Stars.* Pp. xii + 309. Illustrated. McGraw-Hill. $3.75.

BAUMGARTNER, LEONA and JOHN F. FULTON. *A Bibliography of the Poem Syphilis Sive Morbus Gallicus.* Pp. 157. Illustrated. Yale University Press. $5.00.

BLANCHARD, RAOUL and RAYMOND E. CRIST. *A Geography of Europe.* Pp. xvii + 490. 188 figures. Holt. $3.50.

BORING, EDWIN G., HERBERT S. LANGFELD and HARRY P. WELD. *Psychology: A Factual Textbook.* Pp. xviii + 555. 129 figures. Wiley. $2.75.

DE BOER, J. H. *Electron Emission and Adsorption Phenomena.* Pp. xi + 398. 150 figures. Cambridge University Press, The Macmillan Company. $5.50.

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HENDERSON, LAWRENCE J. *Pareto's General Sociology.* Pp. 119. Harvard University Press. $1.25.

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